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# Transactions of American Society for Steel Treating

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*Scene in Central Steel Physical Laboratory*

# Your Problem IN Steel—Worked Out by Experiment

Many manufacturers who have long thought of the possibilities of using Alloy Steels for certain parts of their products have put off and put off actually deciding the question. To determine such an important subject, they have thought, would take perhaps years of research work and otherwise be a long-drawn-out and costly process.

The fact of the matter is that our Research Laboratories have been engaged for years in the preparation and compilation of data on every kind of commercial alloy steel—Nickel, Uma, Chromium, Vanadium, Molybdenum, etc., and are in position to short-cut into the heart of any problem that is *in* the steel.

What is the part or product you want to make stronger, tougher, lighter, harder, more wear resistive? We can tell you the right steel quickly and prove it by experiment. Such service is without cost to you.

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# AGATHON ALLOY STEELS

# *TRANSACTIONS*

*of the*

*American Society for Steel Treating*

Vol. III Cleveland, November 1922 No. 2


## 1922 CONVENTION

THERE is always a temptation to say that the most recent Convention of the Society is the best in the history of the craft, partly because each annual gathering of the American Society for Steel Treating brings so much of inspiration, so much of genuine pleasure and so much that is helpful, one is prone to forget the excellent conventions that have gone before.

The papers presented though fewer in number than at the previous Conventions were of a very high quality and over 50 per cent of them had been reprinted in the TRANSACTIONS. Consequently the discussion of these papers was more enlightening and instructive than the discussions at previous conventions. Appreciation of the entire membership goes out to those individuals who prepared papers for presentation at Detroit. There is no doubt that service to others through the Society, as well as in other ways, has its natural reaction and that he who serves grows in a fuller understanding of the things worth while and incidentally achieves worldly success.

The Exposition held in connection with the Convention was also a decided success. Manufacturers' representatives had been on the ground for several days prior to the official opening on Monday morning getting things in shape. There was no confusion when the show opened. Everything was ready and Monday proved a mighty good day for the exhibitors, because the visitors who had come in unusually large numbers could devote their undivided attention to the exhibits. Manufacturers had spared no expense to make a proper presentation of their products and it was generally voiced by all those in attendance that the manufacturers were to be complimented and commended for the excellency of their exhibits.

The members of the Detroit Chapter were busy every minute in taking proper care of the members and only the heartiest praise was to be heard on all sides for the success of the Detroit Convention and Exposition.

The Convention and Exposition have set a standard for the future to follow and it is needless to say that concentrated effort and hearty co-operation will be necessary in order that the American Society for Steel Treating may continue to increase its usefulness at its annual meetings.

## RECOGNITION

THERE must be a beginning of all things yet it is seldom the privilege of any individual or any group of individuals to suitably award those who have planted the seeds from which a successful harvest has been reaped.

Nothing makes a more lasting impression than due regard for those who are accountable for a notable achievement, so that it must indeed have been a very propitious and happy occasion for the membership of this Society when upon authority of the Board of Directors, there was conferred upon Mr. Wm. P. Woodside and Mr. Theodore E. Barker, Founder Memberships in the American Society for Steel Treating. Those who are familar with the activities of the two gentlemen in the work of the organizations from which the present Society is the outgrowth are cognizant of the excellent work they did in laying a firm foundation upon which the present structure is erected. The Society in recognizing these two individuals, confers an honor upon itself and future time will tell more clearly than now, how well and important has been the work of these two capable men who have made for themselves a lasting niche in the Hall of Fame of Founders of technical societies.

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## A CONTEST

AT the Delegates' meeting in Detroit, a resolution was proposed and favorably acted upon that the Board of Directors of the A. S. S. T. should be requested to inaugurate a membership contest among the various chapters and offer suitable prizes to the chapters showing the largest increase in membership during a certain period. The Board of Directors took the matter under consideration and appointed a committee to investigate. This special committee reported at the regular meeting in Cleveland on October 27. This committee was moved by the thoughts expressed by many members of the Society that mere increase in membership should not be the sole aim of the organization. It is believed rather that the continued interest of a stable membership with a sound and healthy growth would best promote the aims of the Society.

It therefore recommended that combination prizes be given to the local chapters for percentage of net increase in membership and percentage attendance of members at the meetings of local chapters. It was the committee's idea that one was quite as important as the other, and for that reason each should count 50 per cent toward the prizes.

At the delegates' session the sum of $300.00 was suggested as the amount to be devoted to prizes, but the delegates did not have in mind the questions of attendance. The committee thought that inasmuch as more energy would be required to conduct the combination campaign than would be necessary if only the question of increase in membership were invloved, the prizes should be made larger. For that reason the committee recommended total prizes of $500.00.

The action of this committee and the Board of Directors in arranging this contest so that one of its purposes will be the establishment of a stable membership and a sound and healthy growth of the Society will undoubtedly receive the hearty approval of the entire membership. The rules of the contest are published under Chapter News of this issue of the TRANSACTIONS.

## GENERAL CHAIRMAN LETTER

To The Members of the Detroit Committees

Fourth Annual Convention, 1922.

Gentlemen:—

I desire to express my appreciation and sincere thanks to the chairmen and members of the various committees who worked with me during the preparation and time of the Convention and Exhibition of our Society.

I should like to write each one of you a personal letter but in place of that, I am taking this opportunity to publicly express my thanks so that all members of the Society will be cognizant of your work as well as my appreciation.

My thanks to:

Mr. C. N. Dawe and the members of the Meetings and Papers Committee for the excellent program prepared for the technical sessions as well as the efficient arrangements of the meetings rooms.

Mr. C. T. Bragg and the members of the Finance Committee for their valuable work in raising the money necessary for conducting the activities of the week;

Mr. W. B. Hurley and the members of the Transportation Committee for the excellent manner in which this part of the Convention was taken care of;

Mr. Jack Dailey and the members of the Exhibition Committee for the valuable assistance and services rendered to the National Secretary and to exhibitors;

Mr. F. Walter Guibert and the members of the Publicity Committee for the excellent publicity given the events of the week;

Mr. Arthur Schaffer and the members of the Hotel Committee for their successful efforts in finding accommodations for all of our members and guests;

Mr. W. J. Learmouth and the members of the Ladies Committee for performing a pleasant duty in a most acceptable manner.

Mr. Frank G. Davis and the members of the Entertainment Committee appreciation for excellent services well done in providing entertainment for exhibitors and guests. Detroit regrets exceedingly that Mr. Davis has been transferred to take charge of the Buffalo Territory for the Atlas Steel Corporation and sincerely hopes that the reason for his leaving Detroit was not resultant upon his connection with the Entertainment Committee. In all events we thank him for his capable assistance and wish him well.

My thanks are also due to the Chairman of all committees in that they managed their departments so well that they all kept within the budget allowed them.

Yours very truly,

W. P. Woodside,
General Chairman,
Detroit Convention Committees.

## WHAT THE TRADE PUBLICATIONS SAY

### Iron Age

IN A ten-page review of the activities at the International Steel Exposition and Convention of the American Society for Steel Treating, the Drop Forging Institute and the Drop Forgers Supply association, the *Iron Age* of Oct. 12 says in part:—

"An unqualified success was the general verdict of those who attended the fourth annual convention and exhibition of the American Society for Steel Treating last week at Detroit, Oct. 2 to 7. The record made there by this society, only three years old, both in technical papers and in exhibits, insures it a place among the leading technical organizations in the country and stamps its annual meeting as one to be looked forward to and to be reckoned with. Both the convention and the exhibition, called this time an 'international steel exposition,' exceeded in scope and attendance the three previous affairs at Chicago, Philadelphia and Indianapolis in 1919, 1920 and 1921, respectively. The registered attendance of members only was about 1300 of a total membership of a little over 3000. This is the first year that only membership attendance was recorded. An official estimate of those participating in all activities is 18,000 against 8000 to 9000 last year.

"Uniting with the steel treaters was the first annual convention of the American Drop Forging Institute with which was also associated the Drop Forge Supply association. Their registered attendance exceeded that of the recent meetings of the American Drop Forge association, the older and parent organization.

"The fourth floor of the spacious building of the General Motors Corporation afforded an ideal place for the technical sessions and the exposition, the former being held in close proximity to the latter. As for the city itself, Detroit probably contains in its automobile industries more extensive industrial applications of heat treatment than any other American city.

"The exhibition of heat-treating equipment and processes of heat-treated material by large steel companies and other allied interests was imposing in its scope and impressive in its presentation. In floor space and in material exhibited, it exceeded any previous exhibition. The entire affair occupied about 55,000 square feet of floor space taken by about 100 exhibitors; in Philadelphia in 1920 there were 125 exhibitors but less floor space. Not only the number of steel companies represented but the new equipment and other matters presented were features.

"The exhibits of forging machinery, machine tools and accessory equipment, while not large in numbers, were a noteworthy center of attraction and several machines are said to have been sold.

"The technical sessions of the steel treaters were not only well attended in most cases but, as contrasted with the Indianapolis meeting last year, there were fewer papers and almost no simultaneous sessions. As against nearly 75 papers scheduled on the program last year, this year the various sessions covered 20 to 25 papers, including several symposiums. The sessions were devoted to carburizing, heat-treating problems, tool steel, aircraft failures, with three practical round table discussions on heat treating and three symposiums on metallurgical education, on hardness testing and on research. Most of the papers were available in printed form, a commendable departure from previous con-

ventions. The society's journal, TRANSACTIONS, containing many of them, was distributed.

"Plant visitations were numerous and largely taken advantage of; they included both the Highland Park and River Rouge plants of the Ford Motor Co. and the plants of other large companies.

"A new feature was the holding of regular sessions in Detroit of some of the committees and subcommittees of the American Society for Testing Materials."

## Iron Trade Review

The *Iron Trade Review* of Oct. 12 in a seven-page review of the International Steel Exposition and Convention, makes the following comments

"Probably the widest representation of the iron and steel industry ever witnessed in this country was assembled at the fourth annual convention and exhibition of the American Society for Steel Treating at the new General Motors building, Detroit, Oct. 2-6. At the invitation of this society the American Drop Forging institute and the Drop Forge Supply association held simultaneous and joint meetings with it during the week. Approximately 1300 members of the steel treating society and 150 members of the forging associations were registered while more than 18,000 people attended the exhibition, which was the most complete conducted by the society. About 100 manufacturers of steel, heat treating equipment and materials, machinery and forge products were represented with exhibits. While the success of this year's meeting was assured largely by the continuous growth of the society, the fact that Detroit, one of the country's leading centers for the heat treating and forging industries, was selected as the meeting place added to the interest.

"Features of the program were discussions of practical heat treating problems, sessions on research, employment, metallurgical investigations, production and costs and forging practice. On Thursday a bronze tablet was dedicated to the builders of the first bessemer converter in America. Social functions included a smoker, dance and banquet participated in by the three organizations. Inspection trips to various Detroit manufacturing plants proved to be of interest to many members."

## Chemical and Metallurgical Engineering

*Chemical and Metallurgical Engineering* in its Oct. 11 issue devoted four pages to a review of the exposition and convention. A part of this review is as follows:—

"Steel treaters have done something which is perhaps unparalleled in the history of American technical societies—they have held a national convention at which 40 per cent of their entire membership enrolled was present. Being held in Detroit, several of the larger local chapters in the Middle West came in a body, but in order to set that record a great many others traveled from New England and the coast states.

"They were rewarded by the best meeting and exposition the American Society for Steel Treating has ever had. Being but a young organ-

ization, the earlier conventions showed many marks of inexperience on the part of their managers. Much praise is therefore due to the Detroit committees, under the general chairmanship of W. P. Woodside, for their part of the work. They provided quite adequate meeting and exhibition facilities in the magnificent General Motors Office building, gathered together a notable list of meritorious technical papers, and provided a number of excursions into manufacturing plants and social entertainments which filled every minute. No doubt some of the successful results—particularly in the exposition of steel and steel-treating equipment—were due to the co-operation of the Amerian Drop Forging Institute, which held its annual convention in conjunction with the Steel Treaters as a sort of co-operative affair.

"One feature of the non-technical activities is worthy of comment and emulation. It seems that the first bessemer steel made in America on a commercial scale was blown in 1864 by William Kelly at the village of Wyandotte, on the river a few miles south of Detroit. The site of these works—now long since dismantled—is the business center of the present community, but is now marked by a bronze tablet erected by the Detroit members of the Society for Steel Treating.

"Kelly, it may be recalled, was an ironmaster who had discovered the pneumatic process many years before when observing the action of the air blast on the metal in one of his forges, left unprotected by the usual charcoal blanket. In fact, he had made knobbed iron with little or no charcoal for many years before he was able to interest anyone sufficiently to finance large experiments on what is now known as the bessemer process. A plant was finally erected alongside the blast furnaces of the Wyandotte Iron Works, and operated with the usual vicissitudes of radically new processes for several months. A considerable tonnage of steel, however, was made, rolled and sold. During part of that time Captain Robert W. Hunt was in charge of the operations, and fortunately this venerable engineer was able to be present at the dedication ceremonies and give some reminiscences of those early times.

"An echo of the vicious litigation which was fought over the Kelly American patents, the bessemer British patent and the improvements made by Mushet was heard in the remarks made by William C. Kelly, the son of the discoverer of the pneumatic process. It seems that Kelly's achievements in the manufacture of iron without charcoal had become fairly well known, both here and abroad, through information spread by Kelly's Cincinnati house—jobbers and importers of iron and steel. During these times the forges were visited by two Englishmen of intelligence, who remained a few months, even assisting the owner in his experiments looking toward an improvement of the process or an adaptation to larger-scale operation, eventually leaving as suddenly as they appeared. According to the son, William C. Kelly, one of these visitors was identified by his father as Bessemer, when a photograph of the latter was brought over from England shortly after the introduction abroad of Bessemer's process in a commercial way. This incident, mentioned by William C. Kelly as never before having been made public, was told him by his mother before her death, several years ago."

### American Machinist

The *American Machinist* of Oct. 12 makes the following remarks in review of the fourth annual convention and exhibition:—

"The convention of the American Society for Steel Treating held in conjunction with the annual meeting of the American Drop Forging Institute which was brought to a close last week in Detroit was regarded by all present to have been the most successful in the history of both bodies.

"The total attendance upon the convention was estimated at between eighteen and twenty thousand persons. Of the membership in both bodies, there were thirteen hundred present or approximately 50 per cent of the total.

"The chief feature of the convention was the number of executives present and interest was centered chiefly in the exhibit which was considered to be the most successful ever held, fully one hundred more companies displaying their products than in previous years. Nearly all the machinery displayed on the floor was sold during the convention.

"Tuesday and Wednesday evenings, Oct. 3 and 4 were given up to smoker and carnival frolic. On Thursday, Oct. 5 the annual banquet was held at which the chief speakers were: President Burton, University of Michigan and Frank Hook Alfred, president of the Pere Marquette railway. T. E. Barker and W. P. Woodside, both of whom have been instrumental in establishing and furthering the interests of the American Society for Steel Treating were the recipients of founder memberships in recognition of their work.

"On Thursday afternoon a bronze tablet was unveiled at Wyandotte, Mich., to William Kelly who was the first to use the Bessemer process in America.

"Among the papers read during the sessions of the convention were the following: Furnace Atmospheres and their Relation to the Formation of Scale by G. C. McCormick; The Effect of Structure Upon the Machining of Tool Steel by J. V. Emmons; Case Hardening by A. H. d' Arcambal; Lathe Breakdown Tests of Some Modern High Speed Tool Steels by H. J. French and Jerome Strauss; Heat Treating in Lead by R. B. Schenck; Irregularities in Case Hardened Work caused by Improperly Made Steel by E. W. Ehn; Study of Some Failures in Aircraft and Engine Parts by J. B. Johnson and Samuel Daniels; and Carburizing and Decarburizing in Case Hardening by H. B. Knowlton."

### Western Machinery World

The *Western Machinery World* in its October issue devoted two pages pages in reviewing the International Steel exposition and convention of the American Society for Steel Treating. In part it comments as follows:—

"This convention, held Oct. 2 to 7 at Detroit, has brought out a number of very excellent papers on various technical phases of heat treatment, carburization, case hardening, and metallographical research in steel and ferrous alloys. For the convenience of our readers we are here reprinting through the courtesy of the TRANSACTIONS of the American Society of Steel Treating, abstracts of these papers. *Undoubtedly the* TRANSACTIONS *of this society constitute the best readily available literature on the up-to-date experience of America's foremost experts in steel treating.*"

## THE FOURTH ANNUAL EXPOSITION AND CONVENTION A DECIDED SUCCESS

MODESTY forbids that we sing too highly our own praises—our own praises in respect to our fourth annual convention and exhibition—The International Steel Exposition. This convention beyond all fear of contradiction was an unqualified success. From the pleasant words of commendation and encouragement expressed by many of the leading trade publications we feel that we can be just a little bit proud of the results of our efforts. These efforts were not confined alone to any one individual or group of individuals but was the culmination of the efforts of our entire membership. The members of the Detroit Chapter are to be congratulated upon the very successful manner in which the exposition was handled. They provided an excellent exhibition on the fourth floor of the wonderful General Motors Building and likewise provided a very interesting and meritorious program of technical papers, plant visitation and social entertainment.

The American Drop Forging Institute and the Drop Forgers Supply association who held their convention simultaneously with the American Society for Steel Treating, likewise provided a very interesting convention program and in no small way assisted in making the International Steel exposition and conventions a profound success.

The number of exhibitors was larger this year than ever before and the variety of exhibits was greater than at any of the previous annual expositions. The exhibition hall comprising more than 50,000 square feet of floor space was admirably adapted to our needs and more than 20,000 persons visited the show throughout the week.

As one of the technical papers comments, the American Society for Steel Treating has accomplished something that no other technical society has up to the present time. Out of a total membership of a little more than 3000 members, 1300 were registered as in attendance at this convention. This record has been unprecedented. Perhaps the fact that the fourth convention was held in Detroit, the automotive center, vitally interested in the heat treatment of metals, served as an added incentive for our members and guests to attend the convention and likewise avail themselves of the opportunity of seeing how they do it in the Auto City. Undoubtedly all of these factors had their direct bearing on the success of our show.

For those who were unable to be in attendance an outline of the week's activities may be interesting.

Monday morning at 11:00 o'clock the doors of the exhibition were thrown open. Fully an hour previous several hundred members had registered. From Monday morning throughout the week a steady registration of members was made.

At 2:00 o'clock the opening session of the society was held in the large meeting room adjoining the exhibition hall. The meeting was called to order by L. A. Danse, who gave the following address of welcome to the visiting members and guests.

"I want to express a few thoughts on behalf of the Detroit Chapter. It has been a very real pleasure to us to do the work that we have been doing the last few months. It has taken a great deal of time and

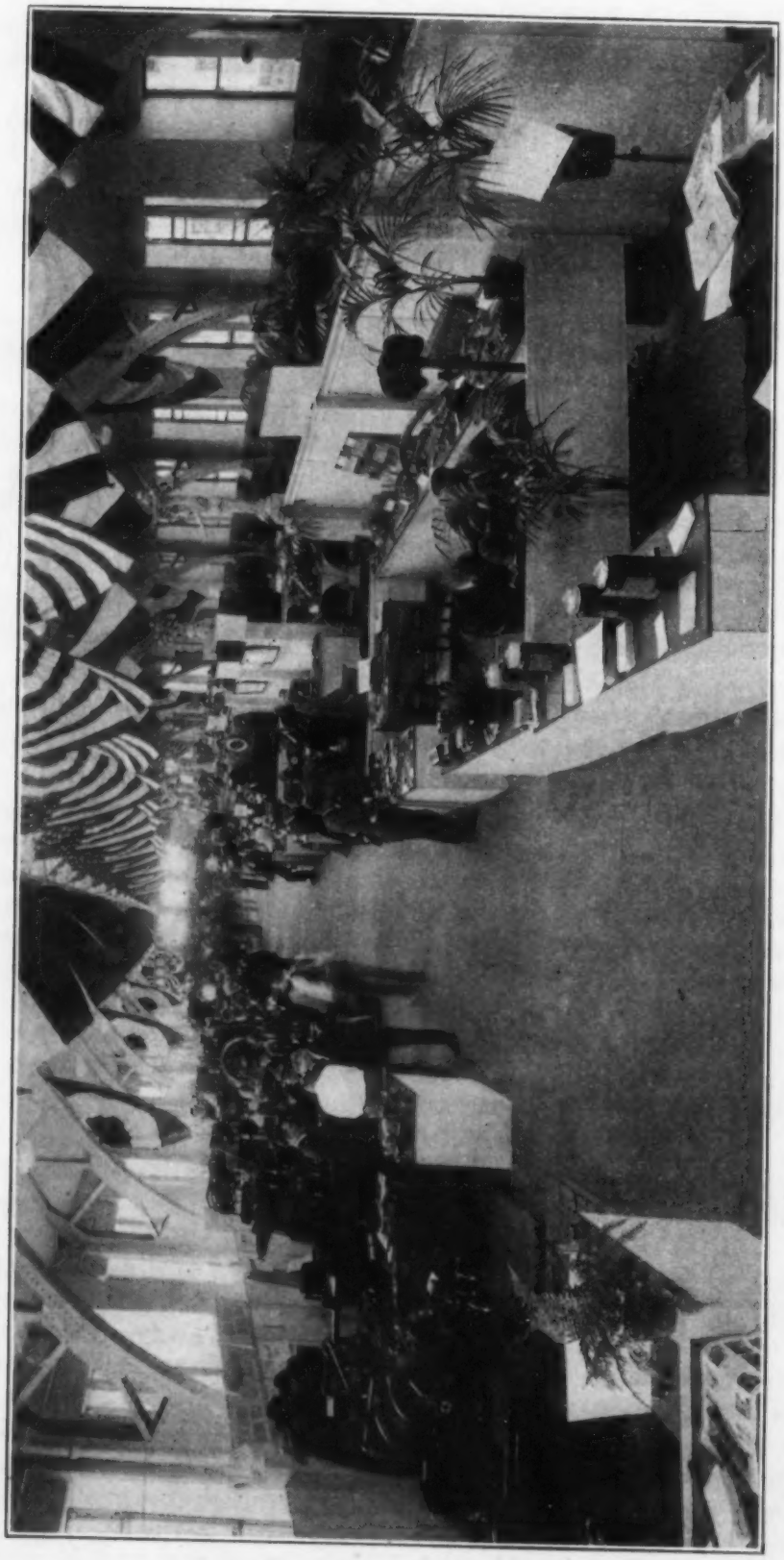
considerable energy, but I don't think that we could have spent too much for the fellows who are coming. We feel that you are pretty much the backbone of the industry. If you fall down, the machine shop can't do a thing. I am pretty much reminded of a remark that I heard Stewart Edward White make at a gathering in Los Angeles. He was a little afflicted with stage fright; he got up and looked at the crowd and said, 'Well, fellows, I am tickled pink to see you, here is Mr. Crossman, he will talk to you.' That is about the way I feel. We have a speaker who can talk. He is going to give you a real hospitable welcome to Detroit. That is beyond my bounds. I am a good deal like my wife's uncle was, one time when we went to visit him. He felt all the hospitality in the world and wanted to make us feel at ease. He was a rough country chap, rather unschooled. His wife tried to coach him a little, and when we went in to sit down to dinner he said. 'Well, folks, I am home, and I wish you were too.' Well, we don't wish you were at home. We want you to feel at home. We had hoped that we would have a grand attendance. From the looks of things it is going to be bigger than we thought. The boys in the Detroit Chapter each one and collectively wish to welcome you, through me. Mr. Bragg has been deputized by Mayor Couzens, who was unavoidably prevented from coming, and Mr. Bragg will present to you the respects of our city's chief executive." (Applause).

**Mr. Bragg:** "Mr. Chairman and gentlemen, I am afraid I make a rather poor substitute for the Mayor, and yet a rather fortunate one, too, in a way, because I am interested in his administration as one of his commissioners.

"The Detroit Chapter has done a lot of very hard work, and no one appreciates it more than the Mayor. The Mayor told me yesterday that he had decided to attend your banquet on Thursday night,—and if you would excuse him this afternoon he would surely come to the banquet. He doesn't go very many places, but where he does go you may be sure he is taking a keen interest, and he will be there on Thursday night. The Mayor has made during his administration something of a record. However, he has to a certain extent retired from his politicial career and is more or less based on the steel business himself, so he is interested in everything that you do.

"We are saying to you that we are glad to have you come to Detroit. This is quite a convention city, and we have a lot of things here for you to see. I know, that about this time a year ago I was concerned with a certain convention, and we met to take up the plant visitation proposition, much as you have outlined in your program at this meeting. We soon discovered the problem was not where to go, but where not to go, or where to stay away from; there are so many big industries in Detroit it would keep a fellow busy if he spent all of his time in going around.

"I will say once more to you that the Mayor is particularly interested in the success of the convention and he would have been here personally today were that not absolutely impossible. I know you are going to have a long, hard program to go through during the week of the convention, and all of you should attend these meetings and if you do, you are going to hear about all the talking and about all the paper



Courtesy *Iron Trade Review*

VIEW OF MAIN EXHIBITION HALL, INTERNATIONAL STEEL EXPOSITION, GENERAL MOTORS BUILDING, DETROIT

reading that you want to for a week or more. I will conclude with this and say to you once more that the Mayor will be with you on Thursday night." (Applause).

**Chairman Danse:** "Gentlemen, short and snappy seems to be the rule. I don't know what Mr. Gilligan is going to say, but if I am any judge, from past experiences, Mr. Gilligan is going to beat Mr. Bragg." (Applause).

**President Gilligan:** "Members of the Detroit Chapter, guests, and Mr. Bragg, it gives me great pleasure to thank the representative of the Mayor and the Detroit Chapter for their cordial welcome to this city. It is particularly appropriate that the American Society for Steel Treating should hold this convention in Detroit, because the Society really had its birth in this city, and the industry that made Detroit famous has really raised the heat treating game from a job to a profession.

"We have been to various chapters in the last three or four years with our convention. Each one has been a little bit better than its predecessor, each chapter has worked hard, and from the indications we see here today, Detroit is going to maintain that record.

"I am sorry that our 'Granddaddy,' Mr. Woodside, is not with us, for a few remarks just now. The attendance is going to be exceedingly large, however, because Detroit is not alone attractive as the home of the Steel Treating Society, but also for the varied industries here, and I am pleased to accept the cordial welcome to Detroit." (Applause).

**Chairman Danse:** "Mr. President and Gentlemen, I think the next item on our program is a thing which will interest Mr. Gilligan and Mr. Lynch more than anybody else. I don't know what kind of an expression I will see on Mr. Gilligan's face, he doesn't want to look at me right now. We are due to hear the report of the Tellers of Election." Mr. Simpson read this report which is as follows:

For President—one year—T. D. Lynch
For 2nd Vice President—two years—W. S. Bidle
For Secretary—two years—W. H. Eisenman
For Director—two years—S. M. Havens

**Chairman Danse:** "Congratulations to you, President Gilligan, on your past very successful year, and to you, Mr. Lynch. We are going to give you all the co-operation we possibly can the coming year.

You have heard the report of the Tellers. Its acceptance is in order." The report was then accepted by vote.

"It is now in order to introduce your newly-elected officers. (Introduces them). Now I am going to ask Mr. Lynch to take the chair and make a few remarks, and he will call for the reports of the National Secretary and the National Treasurer." (Applause).

**President-Elect Lynch:** "Mr. President, fellow members of the American Society for Steel Treating, it is a great pleasure for me to be at this convention and to be the recipient of this honor, but the acceptance of an honor of this sort carries with it a responsibility that I, as your president-elect, can only hope to make a success of through your co-operation, by the co-operation of our National officers, by the co-operation of each and every chapter, and by the further co-operation of each individual member. It is only through work of that sort that we can hope to succeed, as an organization, as we have succeeded in

the past. The details of the work for the coming year will have to develop after we have had a meeting of our board of directors. None of us can tell just what is going to transpire or just what our ideas may be, but in general we certainly have no idea of making any radical changes, of proposing anything radical other than that that was given to us by our fathers and carried on and executed by our predecessors. We feel that they have started well, they have built up an organization worth while, and through those same channels and through that same plan of working I see no reason why we should not prosper.

"There are a few things that are very important in an organization of this kind. Among them is the question of the committee work. I feel that the majority of the work of this Society that is permanent must be done through committee work, and some of those committees, to my mind, should be, perhaps, a little more permanent than they are today, such as the Technical committees, the Standards committee particularly, and the Research committee. Those two committees have work under way that cannot be accomplished in a year or two years. They must plan, they must plan for the future, and in doing that it is my thought that those committees perhaps should be increased in number from perhaps say three to five, and say in addition, to having the member hold office for a term of at least five years, and instead of the president of the Society appointing the chairman of these committees, I would like to see the committee elect their own chairman from amongst their own number, and each year elect new men. These are thoughts that I will lay before the board of directors later on, but is something that will not require the action of this body at this time. However, those are thoughts that it seems to me would be worth while acting on.

"Then in the appointment of the committees, I think perhaps in order to stimulate the committees and the chapters all over the country that the member of the Standards Committee should be the chairman of the Standards Committee of the local chapter which they represent. I think that would tie up the local chapters with the national body more closely, and I think in doing that it would help all of us.

"Now our motto, as suggested by our secretary last year, was *Service*: I think it is a good motto. Not the ability we have, but the ability we show, by Service, will measure our success for the coming year. We cannot lie down and dream ourselves into a success, but we must hammer and forge our way forward. We cannot make a success of treating poor material. Let us see that our material is right and that it is treated right. Don't sit down and take what comes; go after what you want. The best prize that this Society has to offer is the chance to work, to work hard, and to work for a purpose and a work well done. I think, if we will follow these ideas it will give you some idea of what my ideas are of our future work, and I wish to thank you." (Applause).

**President-Elect Lynch:** The next speaker on our list is Secretary Eisenman who will give his annual report.

**Secretary Eisenman:**

The Secretary is pleased to submit this report of the past year. It shows that your Society has been able to extend its service in spite of the fact that we have passed through a year of general depression.

The membership activities show a gain for the year as is evidenced by chart No. 1 which shows that 543 new members were enrolled in the Society, an average gain of 43 members per month. The largest gain of any one month occurred in June when 107 new members were received. This high peak was reached during a membership campaign by the Chicago Chapter.

We regret that all of the 543 members may not be added to the permanent rolls of the Society because during the months of January, February, March and April, 1922, the number of resignations received was at a very heavy rate

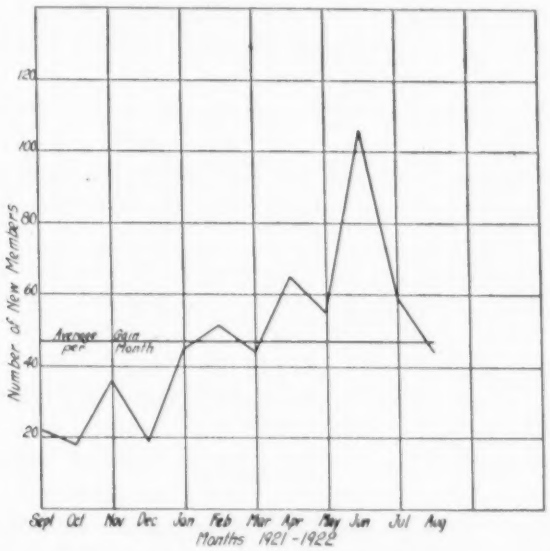



Chart 1. Showing Gain in Membership

inasmuch as many of the members whose dues expired during these months were out of employment and consequently did not feel inclined to continue the expenditure. During the year there were 398 resignations leaving a net gain for the year of 145 members. We feel confident however, that many of the members who permitted their dues to lapse will again take up active work in the Society and our records at the present show that many of these are being reinstated.

The ruling by the Board of Directors whereby the local chapter receives a larger percentage of the dues received from sustaining memberships has contributed materially to increasing activity in this class of membership and has in this way been of great financial assistance to the local chapter.

The Society has not yet made an impression on the field of possible members or its potential usefulness and there is every reason to believe that the coming year, with business conditions so much better the membership line will show a gradual increase from month to month, and we will close the year with a fewer number of resignations and a larger total of members.

As stated in the annual report of President Gilligan, the TRANSACTIONS has made commendable progress during the past year. The TRANSACTIONS this year contained 1238 pages of editorial matter, as compared with 840 pages published in Volume I. This is a net increase of 398 pages or about 47 per cent. An increase in the number of pages does not always indicate an increase in value to the members, however we are strong in the belief, judging from the many commendable letters that we have received from home and abroad, that the TRANSACTIONS is and will continue to be the leading publication on the heat treatment of steel.

Special commendation should be given to the Publication Committee in-

asmuch as they have given very largely of their time in reviewing papers and have been of very great assistance to the editor. We should not be unmindful of the firms using the pages of the TRANSACTIONS as an advertising medium. Many advertisers continued in the TRANSACTIONS even after they

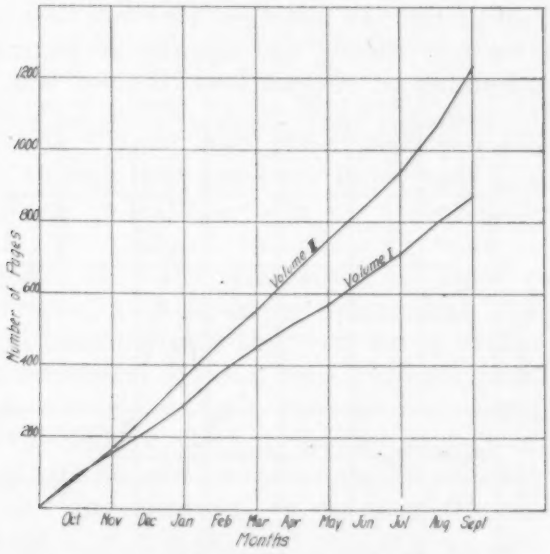



Chart 2. Showing Increase in Pages in TRANSACTIONS

had withdrawn from other publications. This support and co-operation from them is greatly appreciated by our entire membership.

About 150 members availed themselves of the opportunity to have their TRANSACTIONS bound at cost, by the National office, and the same plan will be continued with Volume 2.

Your Society sustained serious loss during the past year of one of our Honorary Members, Henry Marion Howe, and in commemoration of the exceptional achievement of Dr. Howe, the Board of Directors decided to set aside a fund of the Society in order to establish a medal to be known

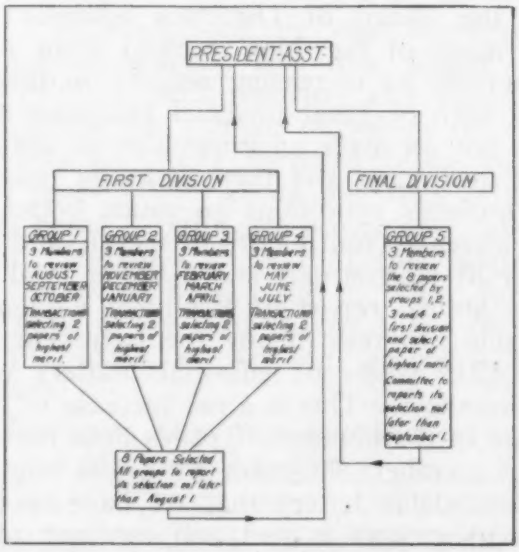

PRESIDENT-ASST.
FIRST DIVISION
FINAL DIVISION
GROUP 1
3 Members to review AUGUST SEPTEMBER OCTOBER
Transactions selecting 2 papers of highest merit
GROUP 2
3 Members to review NOVEMBER DECEMBER JANUARY
Transactions selecting 2 papers of highest merit
GROUP 3
3 Members to review FEBRUARY MARCH APRIL
Transactions selecting 2 papers of highest merit
GROUP 4
3 Members to review MAY JUNE JULY
Transactions selecting 2 papers of highest merit
GROUP 5
3 Members to review the 8 papers selected by groups 1, 2, 3 and 4 of first division and select 1 paper of highest merit
Committee to reports its selection not later than September 1
8 Papers Selected All groups to report its selection not later than August 1

Chart 3. Showing Method To Be Used in Selecting the Howe Medal Winner

as the Henry Marion Howe Medal. The rules governing the award are as follows:

(1) The Board of Directors of the American Society for Steel Treating has established a fund to be known as the Henry Marion Howe Medal Fund, the proceeds of which shall be used annually to award a gold medal to be known as the Henry Marion Howe Medal.

(2) This medal shall be awarded to the author of the paper which shall be judged to be of the highest merit. All papers in order to be considered must be published originally in the TRANSACTIONS of the Society during the twelve months ending August 1st of the year in which the medal is awarded.

(3) The competition for the Henry Marion Howe Medal shall be open to all.

(4) The award shall be made by the Board of Directors.

(5) The award may be withheld at the discretion of the Board of Directors.

The rules governing the selection of the Committees on Awarding the Henry Marion Howe Medal are as follows and are graphically illustrated in Chart No. 3.

(1) There shall be appointed by the President, not later than June 1st of the year in which the medal is to be awarded, a committee on awards consisting of two divisions, the first of which shall consist of 12 members, divided into four groups of three each, each group being located in adjacent territory to facilitate meeting.

(2) Each group shall be assigned three monthly issues of the TRANSACTIONS and it shall be the duty of each individual of each group to read carefully all of the papers published in the three assigned issues and to select the two papers which are, in his judgment, of the highest merit.

(3) When each of the members of a group has made his selection, a meeting of all three shall be held and they shall select the two papers which, in the opinion of the majority, are of highest merit.

(4) Each of the four groups having reached its decision in a similar manner, four sets of two papers each will have been selected for final review.

(5) Each group committee shall report the papers selected by it to the President as soon as a decision is reached, but in any case not later than August 1st of the year in which the medal is to be awarded.

(6) The second division of the committee shall consist of three individuals to whom shall be assigned the eight papers selected by the four group committees.

(7) The second division of the committee shall decide which of the eight papers submitted to it is of highest merit, completing its work before September 1st, and sending its decision to the National President so that announcement and presentation of the Henry Marion Howe Medal may be made during the annual meeting.

**President-Elect Lynch:** "Gentlemen, the next item on the program will be shifted slightly, and we will have the announcement of the winners of the gold and silver medals for the best papers presented at the Indianapolis convention, by our Vice President, Mr. Allen."

**Vice President Allen:** "Prior to the Indianapolis convention it was announced that a gold medal and a silver medal would be given to those who had presented the two best papers during the year. Following the convention all the papers presented were read by the publication com-

mittee, and some 24 were set aside for further consideration. President Gilligan then appointed a committee consisting of Prof. C. H. Mathewson of Yale University, Mr. G. R. Brophy of the Research Laboratory of the General Electric company, and the speaker. Each of the members of that committee read all of the 24 papers, and then we had a meeting in Springfield at which the final selections were made. It was no easy matter, however, to select the two papers, because there were so many of such a high order of merit that it was only after much consideration and discussion that we arrived at a decision on the two.

"Your committee, having carefully read the papers submitted for our consideration, believe the gold medal should be awarded to Mr. E. J. Janitzky for his paper entitled 'A Contribution to the Problem of the Influence of Mass in Heat Treatment,' which, although it may indeed leave this broad subject open for further consideration, constitutes a bold and forceful attempt to express the effects of heat treatment in terms of mass and volume of the object treated.

"The committee believes that the silver medal should be awarded to Messrs. J. P. Gill and L. D. Bowman for their thoughtful and comprehensive paper on the 'Metallography of High Speed Steel.'

**Mr. Janitzky:** "Gentlemen, I thank you for the honor that has been bestowed on me. I would say that it is a big field for research work. Really all the experimental work that has ever been carried on in this field has never been given consideration, but, on the contrary, has been laid aside and pigeon-holed and forgotten. There is really a wonderful lot of data that has been written that could be put within the reach of everybody and which could be explained and used in the practical shop. It is a big field, and there is plenty of it to work on, and I hope there will be many such subjects that will be worked on in the same way. Thank you." (Applause).

**Chairman Lynch:** "Gentlemen, we will now hear the report of our treasurer for the past year, Mr. Emmons." (Applause).

**Treasurer Emmons:** "Mr. President and Gentlemen, I had hoped to show by means of lantern slides the curves which would show completely the exact financial status of the Society. Unfortunately, the electricity hasn't yet been turned on, and I will have to give verbally, as well as I can, the report.

In reporting briefly the status of the financial affairs of the Society, it seems first advisable to call attention to certain policies which have been inaugurated during the past year.

First, it has been found that the most suitable time for closing the books of the Society was December 31st. The fiscal year of the Society was accordingly established as January 1st, to December 31st, inclusive.

The policy of publishing an annual financial statement and balance sheet was anaugurated and the first certified financial statement of the Society was published in the May TRANSACTIONS covering the year of 1921.

A system of controlling the Society's finances by means of a budget has been worked out by the Finance Committee and is now undergoing its first year's trial.

The budget expected receipts for the year of $65,525.00 and expenditures of $62,316.00.

For the eight months ending August 31st, the total receipts exclusive of convention were excepted to be $35,505.00. The actual receipts were $31,-

078.00, being a shrinkage of $4,427.00, or 12 per cent. This shrinkage in the expected receipts necessitated a corresponding curtailment of our expenditures.

The expected expenditures exclusive of convention for the past eight months were $32,536.00. The actual expenditures have been $29,237.00, a shrinkage of $3,299.00, or 10 per cent. It is thus evident that our expenditures have been kept within a working margin of our income.

For the months of July and August, our income has been again exceeding our expenditures and our surplus has regained some of its losses during the earlier months of the year. This improvement has been largely because of increased receipts from dues.

Upon August 31st, the surplus of the Society above all liabilities and necessary reserves was shown by the books to be $7,444.20. Of this surplus $3,718.26 was in accounts receivable, $1,432.37 in office furniture and fixtures and $2,293.57 in working cash.

As soon as possible after the close of the fiscal year, a complete financial statement for the year 1922 will be published in the TRANSACTIONS.

**President-Elect Lynch:** "We have saved the best until the last, and we will now hear from our president, Mr. Gilligan."

**President Gilligan:** "I am glad to hear the treasurer's favorable report because not alone the directors, but the finance committee, consisting of Mr. Emmons and Mr. Campbell, and Mr. Herron, and Mr. Bidle met frequently and long and endeavored to provide a means of conveying to each member all the facts and a clear exposition of the financial progress of this society.

"I want to comment on some of the phases of Mr. Emmon's report, but I will hold those back until I arrive at the opportune time. Owing to the press of other work, I had difficulty in getting my annual report together, so I followed the advice of one chap who had prepared a technical paper for presentation before the A. S. T. M. he decided to pattern it after the modern skirt, 'long enough to cover the subject but short enough to be interesting.' (Laughter).

"Custom decrees that the retiring president shall render a statement covering the most important activities in the life of the society during the year then ending, much as the members of a commercial corporation demand from the officers a statement of the year's transactions in order that they may judge whether they are sailing or drifting.

"Because of various reasons which have little relation to the real principles of steel treating, a new style has arisen in late years in the rendering of some annual reports—known as the sandwich style. The first layer of the sandwich outlines the unusual and extremely depressing state of the health of the world in general, the meat layer carries the disagreeable news, and the final layer consists of a fervent prayer for the future, accompanied sometimes by a request for a contribution. Those who have considered at all the reports just rendered by our treasurer and our secretary will agree that the sandwich in this instance is not a disagreeable one.

"Notwithstanding the disturbed mental balance of the world in general, and of the unstable industrial conditions that have prevailed in our country in particular, our society shows in no uncertain manner

Courtesy *Iron Trade Review*

VIEW OF MAIN EXHIBITION HALL, INTERNATIONAL STEEL EXPOSITION, GENERAL MOTORS BUILDING, DETROIT

that it has been sailing and not drifting. Your officers do not presume to congratulate themselves upon this state of affairs, because our fortunate position is due to many factors, the foremost of which dates back to those early days when two of our members sensed the need of the industrial world for an organization of this sort and possessed the vision that gave it form and the courage and determination that inspired others until today we have nearly three thousand earnest members.

"Enduring success is not possible unless one has faith that the work he is doing is for a worthy cause and warrants sacrifices and laborious effort, and it is, therefore, to the individual members who are supporting most energetically the work of the various chapters and giving tangible form to the purposes of this society that your officers feel a great deal of credit for a very successful year should go.

"That there is much work yet to be done before the society fully meets the needs of its membership in general is thoroughly appreciated, and while progress from your standpoint may sometimes appear slow, it is not because earnest consideration of pressing problems by your officers is being slighted; but because we are a young, aggressive and rapidly growing institution and your officers must look well and build well as we go, in order that we may avoid the evils that befall a mushroom growth.

### *Sectional Meetings*

"One of the earliest matters considered by the directors was some method whereby the individual members might be brought into more intimate contact with the society in general and with members in adjoining chapters in particular. It was realized that the National Convention would probably never be held in many cities in which we had chapters because of the lack of adequate meeting or exhibition facilities and that for such reason, in conjunction with the long distances to be traveled and the consequent time and expense, and a great number of our members would probably never have an opportunity to participate in any of the national convention activties; all of which tended to leave in more or less obscurity the invaluable constructive work being carried on by certain chapters and individuals in furtherance of the society's purpose. Hence, it was decided to arrange for two or more sectional meetings each year, the sections to have floating boundaries and to center about chapters that would draw attendance from cities which would probably not present facilities for the national convention. Two sectional meetings were held during the year—New York and Pittsburgh—and the successful outcome of each of these would indicate that your directors had made a wise decision and that the practice should be continued. One precaution should be emphasized, and that is it is not the intention of your officers to permit these sectional meetings to become so pretentious as to create a financial burden or an undertaking beyond the capacity of any single chapter; or to permit them to encroach upon the prestige or scope of our annual convention.

### *Our Transactions*

"Our TRANSACTIONS are the link which binds the individual member to the national organization. Until this year the society depended upon the national convention entirely for material for the TRANSACTIONS.

The disadvantages of such a method for a monthly publication are self-evident and require no detail mention. The responsibility of editing and preparing the convention papers for publication rested almost entirely upon three men, and few, indeed, of our members appreciate the volume and importance of the work these men handled. Prof. H. M. Boylston was chairman of the Publication Committee and J. V. Emmons and E. E. Thum were the other members.

"When the fiscal year ended last September, J. V. Emmons resigned, by reason of his election as treasurer, and Prof. Boylston asked to be relieved, but kindly reconsidered and agreed to serve as chairman of the reorganized Publication Committee. With a view to distributing the work and lessening the burden upon each individual member, the Publication Committee was increased to nine members, divided into groups of specialists in the various fields of steel treating activities.

"It was evident, however, that a progressive and rapidly developing society could not continue long to conduct its monthly journal entirely upon voluntary and divided editorial direction, and depend upon the papers submitted to the annual convention for publication material. A definite scheme of development involving a publication program projected at least a year ahead whereby (1) prospective contributors might be guided in their choice of submissions and a better balance of new material for publication made possible; (2) a continuing and gradually broadening educational course might be instituted for the information and development of the practical man who wished to become acquainted with scientific principles underlying his work, but who does not want it put before him in six-cylinder or eight-cylinder language; (3) a reliable record of recommended practical and proved heat treating practices for a great variety of machine and tool parts which are common articles of manufacture throughout the country; all to the end that our scientific worker will find our publication a continual source of inspiration and of new ideas; that our practical shop members may find in it reliable information for immediate application as well as a clear and simple exposition of the principles of steel treatment and of the phenomena connected therewith; and that non-members may better appreciate the value of membership in our society.

"With such thoughts in mind and with a determination to make our TRANSACTIONS a leader in the field of applied ferrous metallurgy, your directors engaged a full time editor, who was recently introduced to you through the columns of the TRANSACTIONS. Mr. Bayless took hold May 1, and is thoroughly in sympathy with the views of your officers and promises to give material form during the coming year to the program outlined.

"Now one of the obstacles that confronted me when I tried to get a full time editor on the job was that the society couldn't afford it. My answer was, that the society couldn't afford to go along without it. I believe it was a justifiable increase in expense, and furthermore, he has saved his salary thus far. I am not for any policy of restriction, cutting down your expenses to such an extent that this society is just going to dry up and die of dry rot. We have to meet the needs for which we were organized. The only way to do that is to get the money and spend it, well and wisely. We have not obtained our full growth.

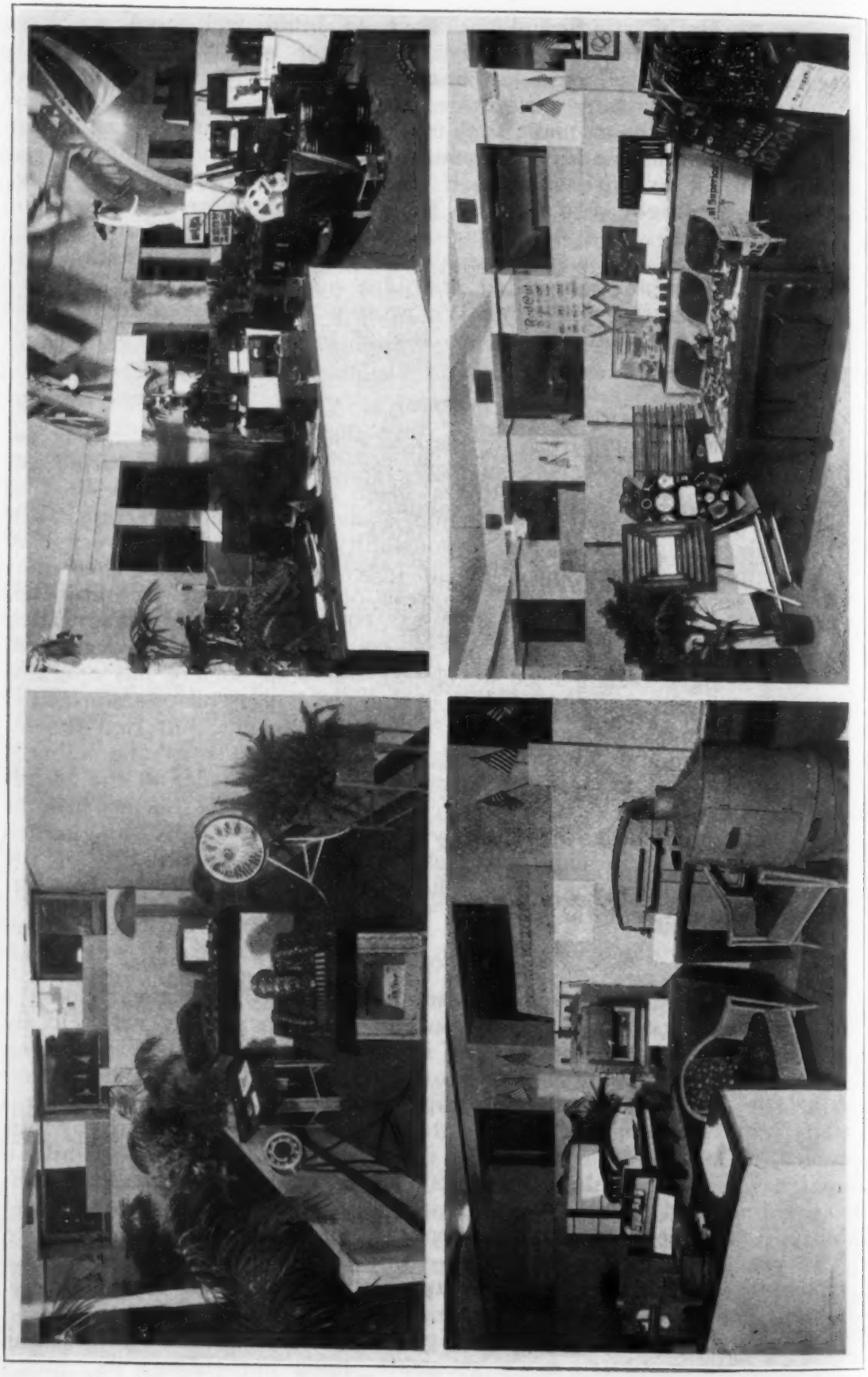
We are merely starting, and we have to build well, and we have to look out for the future. Simply because the society has five or six or seven thousand dollars today doesn't mean very much, to, at least, anyone who has had any business experience. It will take only a few months of hard times to make that minus, because in running an organization of this kind we have to contract with our printing firm. You cannot chop off expenses like that. You have obligations that, if we shut up shop tonight, you have to pay, and if we were to draw upon that surplus you would be surprised what was left. I have no argument when anybody wants to delve into our financial situation, but I do want to continue to combat that idea that we are a little bit of a thing, and we want to draw in. We want to meet the requirements of our members. The only way to do that is to go ahead and do it constructively. (Applause).

*Finances*

"The Finance Committee, directed by your conscientious and painstaking treasurer, is deserving of your thanks for its work during the past year. Our society has always been fortunate in its choice of treasurer. Each has left behind him a most creditable record. The work involves a great deal of responsibility and requires a very considerable amount of time and study, in order that our balance sheet may reflect no serious losses. The progress of our present treasurer has succeeded in meeting the responsibilities of his office and in inaugurating a financial program of a very high order has just been shown. Not only has a budget system been developed, but your society has operated under that system since Jan. 1, and our treasurer has demonstrated that it is not to be interpreted as a harmless warning; but that it constitutes a fundamental financial program that is respected and adhered to. The financial course of the future has been charted and the means provided whereby the detailed financial progress of this society can be determined from month to month by your directors. Thus safeguarded we should be able to cope successfully with any eventuality of the future—provided only that they who direct the activities of this organization simply read the signs as they pass along.

*Membership*

"When the budget system was adopted by the directors early in the year, it became necessary to scan our membership records very closely in order that the estimated income for the year might be based upon reliable data. Our membership records received a thorough inspection and the curve of total membership dipped noticeably. This dip was prevented from becoming serious by the strong efforts put forth by our secretary in co-operation with the Membership Committee. While a campaign for new members was pushed, the campaign was along conservative lines and avoided any attempt to create a growth which lacked stability. A large turnover in membership was inevitable and could not be prevented in the transition from an exceedingly busy period to one of extreme dullness, aggravated by uncertainty as to the future. Now that the horizon is clearing, a continuous healthy growth should be maintained without any difficulty if the society and its various chapters will continue to concentrate upon providing its mem-



GROUP OF BOOTHS AT INTERNATIONAL STEEL EXPOSITION, GENERAL MOTORS BUILDING, DETROIT

bers with reliable and practical information on the various phases and applications of steel treating principles.

*Our Chapters*

"The chapters have the same relation to our society that the nerves and heart do to the human system. What benefits one benefits the other; and what adversely affects one also reacts adversely on the other.

"The most striking characteristics I observed during my visits to the various chapters was that the well being of a chapter depends to a very large extent upon the relation of its meeting program to the daily needs of its members. The majority of our members join the society with a desire to learn and a will to help the other fellow; and where the interest has lagged or the meetings have become desultory, it is simply because the officers and committees responsible for the chapter program have failed to sense or to respond to the needs of the occasion. This society has an amazing wealth of most excellent material to draw upon for our chapter meetings. It is true that some of it requires coaxing, but the results obtained have shown very plainly that it pays to have those responsible for the chapter program go to unusual ends to gain the confidence of the practical man—the artisan—and get him on his feet. We must continually keep in mind that the art of steel treating preceded the science of steel treating and that the artisan can still accomplish many things for which the scientist has yet to evolve a universally accepted explanation. Just so long as our chapters grow in their knowledge and understanding of the principles that underlie the art and science of heat treating, so long will this society continue to grow and prosper; hence, it behooves us to give very earnest consideration to the development of our chapter programs and to the selection of our chapter officers and committeemen. There are too many available men and too much available material to allow our chapter activities to suffer, although I regret to have to state that a few chapters have not advanced as they should.

"Chapter finances have been a troublesome matter in some instances. The directors have given this matter very serious consideration during the past year and made certain changes in the distribution of dues that will aid nearly every chapter in a substantial manner if it will but attempt to develop its membership possibilities. The margin between National society income and outgo is not large enough to permit the society to alter materially the present division of dues.

"Quite a number of chapters are conducting night school courses which are meeting with pronounced success. Our editor is collecting material for a series of lectures so that the National office may be in position to supply any interested chapter with material aid in connection with institution of educational courses. Northwest chapter, with a membership of about 50, had in the neighborhood of 70 members enrolled in its course when I visited it. Chicago, Philadelphia, and Worcester are carrying on similar work, as will be explained at the Delegates Session.

"If we look well after the health of our chapters and build so that the editorial staff and the TRANSACTIONS will function as the heart of the system and act as a constant source of inspiration to each chapter

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and every member, we need to have little fear as to our future welfare.

*Research*

"One of the founders of our society emphasized the need of properly directed research in the course of an address before the Chicago chapter about four years ago. We have not yet attained the goal he set at that time, but we are on our way, under the able direction of our former president, Colonel A. E. White.

"Our Research Committee is planning to act as a clearing house; to the end that those individuals and institutions possessing talent and facilities for research may be provided with problems of practical interest and importance for solution; and, in addition, that data already in existence as a result of previous research, investigation or study by individuals outside the active membership of this society and not generally known may be collected and supplied to those in need of such special information.

"The Research Committee will hold an open session later in the week, at which time it will outline its program and report upon its accomplishments thus far. Every member is urged to consider it his duty to attend this session and aid the Committee, and the Society and serve those purposes for which it was instituted.

"And there is the place for you to express your views and opinions, regarding research. The present board of directors hasn't the slightest intention, hasn't started and doesn't intend to start, any fund to finance research on a large scale, or on a small scale, because we don't consider that any of our business.

*Standards Committee*

"The Standards Committee has a great responsibility resting upon it and an equally great opportunity confronting it. The members are acting wisely in delaying the promulgation of a definite program until after they have had an opportunity to confer with the membership of the society at the Standardization Session.

"Too many independent bodies are laboring on standardization work, and if great care is not exercised chaos rather than order will prevail. Therefore, it rests upon our members and the Standards Committee to consider carefully what problems are wholly within our field and what problems are only partly ours.

"There are a number of subjects that border on or are within the field of steel treating that are under consideration by other societies, such as the American Society for Testing Materials, and the Society of Automotive Engineers. These societies have been established for many years and have earned the confidence of industrial and technical leaders by their sane standardization work; whereas we have yet to demonstrate our ability and probity. Hence, it is very essential that the personnel and the program of our Standards Committee and its subdivisions should be so developed as not to hinder the progress of construction work in other technical bodies. We must be able to respond promptly and adequately when the opportunity to co-operate is presented, and we should be prepared to lead wisely and prudently when leadership is proper.

"Close observation of the workings of the Standards Committee

during the past year leads me to repeat the recommendations I made early in 1921, when a member of the committee; namely, that the Standards Committee as now organized should act solely as a directing unit. It should develop a general program of precedure and control, and should appoint a series of sub-committees or divisions made up of both practically and scientifically trained men who are specialists in the particular activity assigned to each division for investigation, consideration, and recommendation. The chairman of such sub-committees or divisions should not be restricted to members of the main Standards Committee as now organized, nor should membership on a sub-committee be restricted to members of this society, were it found at any time that competent specialists or practical steel treaters outside the society were well versed in a particular line of investigation and were willing to co-operate and aid in the promotion of the work of any unit.

"Such a scheme of organization will enable us to build up an organization that will demonstrate by worthy performance and not by the mere mandate that we are entitled to that confidence from the industrial world which is so essential for success. Once our ability to deliver the goods is proven, industry will follow the path of least resistance and turn to the A. S. S. T. when aid is desired on steel treating problems.

"This statement covers briefly the high spots in the activities of the society during the year just closing. Our secretary's report records the election to honorary membership of three distinguished laborers in the scientific world and in the field of steel treating—Henri Le Chatelier, John A. Mathews, and Elwood Haynes,—also of the establishment of the Henry Marion Howe Medal award, in honor of our former patron and honored member.

"Now the rules are not in shape for publication. The directors have to meet this week and we hope to have the announcement ready before these sessions close.

"All things considered, I believe it can be safely concluded that the record disclosed strong evidence that the quality of the society's work is steadily improving, that its sphere of influence is being gradually extended; with the result that the outlook for the future appears most promising. Definite progress cannot be made, however, without effort, and the responsibility for the attainment of a successful and influential career by this society rests upon each individual member. We must take our membership seriously, and participate actively in the work of our committees, our chapters, and our society, so that both chapter and national officers may be properly guided and supported in their labors to promote the objects for which the society was instituted.

"Now if our officers, either in the chapter or the national, are not properly directed, it is because we have small sessions like this today. I find it difficult to adequately express my thanks for the support I received during the past year, and the many friendships which I made.

"This report cannot be concluded without an expression of gratitude for the encouragement and support I have received from the members of this society during the past year. While the duties required considerably more of my time than I anticipated, I have no regrets. I enjoyed the work and appreciated the opportunities to meet the numerous chapter officers, committeemen and individual members whose unselfish

labors are responsible for the growth and healthy development of our society. There were occasions when I regretted I could not spend more time with some chapters and aid them in the solution of their problems. The number of chapters and the distances to be traveled, however, make it a considerable task for one officer to visit each chapter, and the time will soon arrive when this work will have to be decreased or else distributed among other officers.

"When I became a member of the parent societies early in its life I thought the idea behind it was an excellent one; and now after visiting 29 chapters of this society and observing first hand the workings of both strong and weak chapters, my faith in the value of our work has not been diminished. All the indications point to a very bright future for this society as long as we keep before us the principles upon which it was founded and strive for the attainment of those ends.

"In closing, I desire to express my sincere thanks to our secretary, whose constant good nature and unlimited capacity for work lightened very appreciably my burdens; to our treasurer for his sound advice and invaluable aid in developing an exceptionally comprehensive financial program and businesslike control system; to our National committeemen—and in particular to the members of the Publication Research and Standards Committees—for their labors in behalf of our society; and to my fellow officers and directors for their unfailing courtesy and support in connection with many perplexing problems. To the individual members of this society, who honored me with this office and who have constantly extended their enthusiastic support, I tender my deepest gratitude and thanks. I hope my efforts in your behalf have not been disappointing." (Applause)

**President-Elect Lynch:** "Gentlemen, we have had the pleasure of hearing a most valuable address by our President.

"Is there any other unfinished business to come before this meeting?"

**Mr. Danse:** "I make it a point—it is rather out of order,—that a vote of thanks be recorded for our president, not only given but recorded for our retiring president." The motion was seconded and carried as all arose. (Applause) The meeting adjourned at 4:15 P. M.

## Carburizing Section

Tuesday morning at 10:00 o'clock the first technical session was called to order by Prof. H. M. Boylston, Case School of Applied Science. The program for this session consisting of three papers was opened by H. B. Knowlton, Vocational School, Milwaukee, Wisconsin, who presented his paper entitled "Carburizing and Decarburizing in Case Hardening." The author discussed some of the factors which determine the success or failure of the process of carburizing in commercial practice. He pointed out that successful carburizing must produce a case of uniform depth in all specimens in a given furnace charge. The use of test pieces placed in the pots instead of depending entirely upon thermocouples placed in the muffle furnace was advocated. The temperatures indicated by thermocouples in a muffle furnace show only the temperature of the gases which are in turn affected by the temperature of the linings and of the charge. The temperature of the linings of the furnace and the ratio of the mass of the charge to that of the linings are important points bearing on the speed and uniformity of heating. While pyrometers may frequently fail to indicate the speed and uniformity

of heating pots of varying sizes in a furnace charge, the use of test specimens which may be withdrawn at given intervals and fractured, give an accurate check on the rate of carbon peneration. Photomicrographs were used in demonstrating that within reasonable limits the depth of penetration of carbon in the pieces contained in a given case, could be determined by this test bar method. The method has the advantage that in the event an insufficient case has been obtained, the charge can be run for a longer period of time thus eliminating the necessity of reheating pieces that show an insufficient case after the specimens have cooled.

The carbon content of the case, which is one of the most important factors in carburizing was discussed by the author. He pointed out that the amount of carbon at the surface of the material will be affected by the kind of carburizing material used, the temperature, the pressure and the method of packing as well as the rate of cooling. The author expressed a preference for the use of the microscope instead of the file test and scleroscope in determining the carbon content of the case. In discussing decarburization the author stated that the best way to control this condition was by the use of strong carburizing materials and well sealed carburizing boxes. The specimens should be placed well below the top of the carburizing material so that they do not become uncovered during heating.

The second paper of this session was entitled "Case Hardening" and was presented by Mr. A. H. d'Arcambal, metallurgist with the Pratt & Whitney Co., Hartford, Conn. The work covered by Mr. d'Arcambal's paper dealt with cyanide case hardening of specimens and the effect of nitrogen (iron nitride) in the case as it affects the final product especially in withstanding impact.

In the first part of this paper the author discusses the chemical reactions taking place in a steel treated by the cyanide process. The salient points brought out are:

1. Steels given the cyanide treatment are both carburized and nitrogenized, the resulting hardness, however, being due principally to the absorbed nitrogen, as the carbon is too low to produce file hardness. Medium carbon steels containing over .045 per cent nitrogen possess no ductility whatsoever, thus accounting for the brittleness in cyanide treated specimens. It is claimed that nitrogen causes greater brittleness in higher carbon steels than in steels of low carbon content, it is evident that it is folly to use a cyanide bath for reheating carburized specimens or as a heating medium for carbon tool steels.

2. The amount of carbon and nitrogen absorbed is dependent upon the time and temperature.

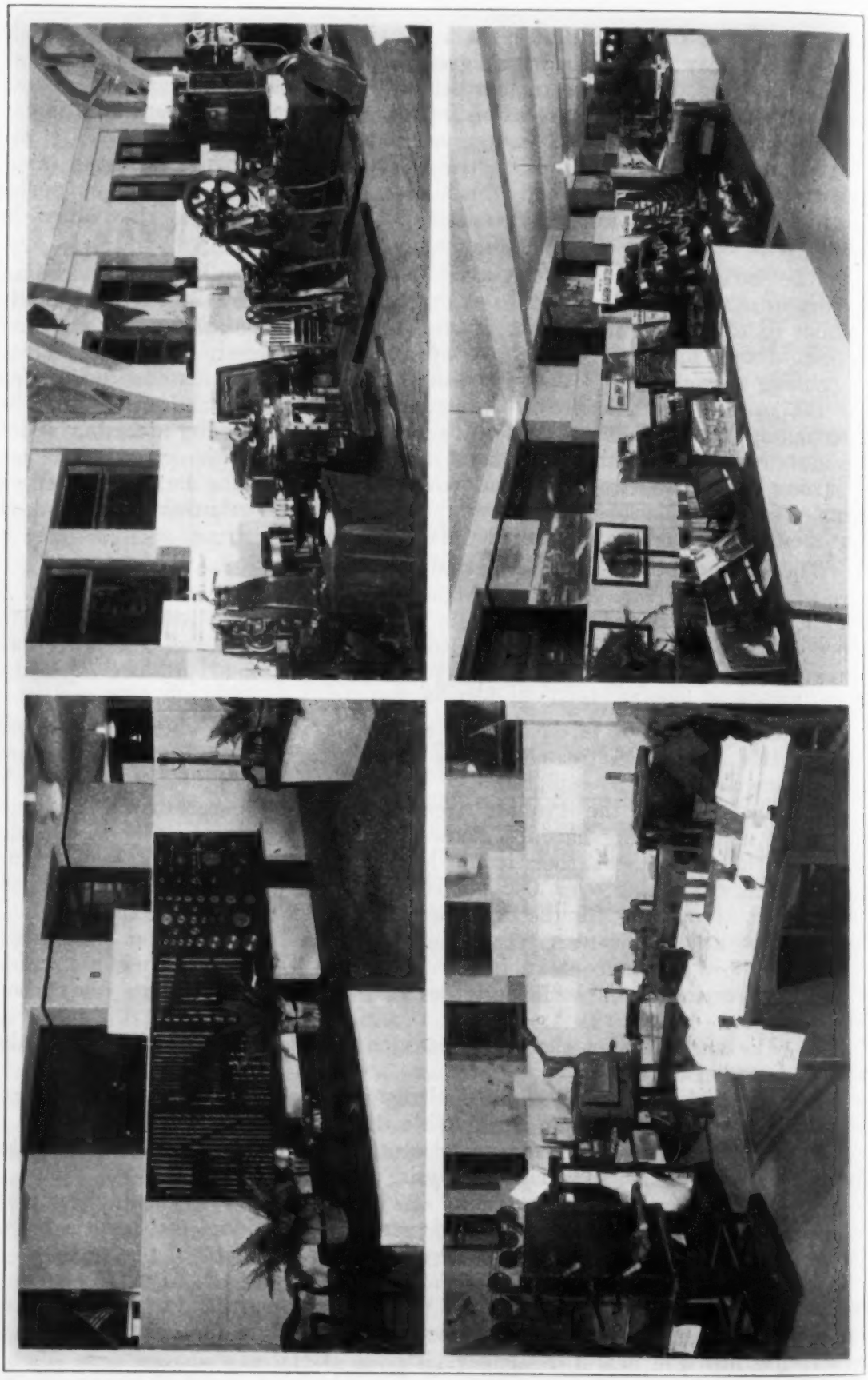
3. The highest concentration of nitrogen and carbon is found in the first .005-inch layer removed from the outside diameter of the specimen.

4. Nitrogen penetrates the material to a slight extent throughout the entire cross-section as shown by analysis.

5. Nitride needles are not found in the areas showing the highest concentration of nitrogen but are found near the breaking off point of the case. Nitrogen in the concentrated area appears as patches of pearlite.

6. The depth of case measures about the same in each of these samples, from .008 to 0.10 inch deep. Longer time at temperature does not increase the total depth of penetration but does produce a greater concentration of carbon and nitrogen near the surface.

The second part of this paper deals with Izod notched bar tests on



GROUP OF BOOTHS AT INTERNATIONAL STEEL EXPOSITION, GENERAL MOTORS BUILDING, DETROIT

several well known types of case hardening steel. The results of the notched bar tests conducted on plain carbon and alloy steels, carburized and both single and double treated, were discussed by the author. S. A. E. 6120 steels gave the highest impact values when double quenched. S. A. E. 3115 gave the lowest reading for alloy steels tested. S. A. E. 1015 and 1112 steels gave very low readings. All alloy steels showed lower impact readings after carburizing and single quenching for case refinement only, than was found on the specimens double treated after carburizing.

Impact tests conducted on the different types of steels, packed in sand instead of carburizing compound and then double and single treated. The results on these double treated specimens are in their order of magnitude from the highest to the lowest, S. A. E. 1015, 6115, 1112, 2315 and 3115.

The discussion of this paper seemed to point out that it was the general opinion that impact testing has its limitations and the method of test is not fully adapted to give comparative results on all grades of material.

Mr. E. W. Ehn, metallurgist with the Timken Roller Bearing Co., Canton, Ohio, presented the third paper of this session entitled "Irregularities in Case Hardened Work Caused by Improperly Made Steel." The author summarizes the contents of his paper as follows:

1. Failure in case-hardening, especially in reference to soft spots, is often due to improper steel. Variation of structure of a carburized piece gives a direct indication whether the steel is suitable for carburizing or not.

2. Coarse-grained structure in case and core of carburized steel with large crystals of pearlite, and clean cut cementite areas in the hyper-eutectoid zone, are signs of good or normal steel. Curly cementite, disintegration of pearlite in hyper-eutectoid zone, and fine-grain size with rounded pearlite areas in the gradation zone and core are signs of an abnormal steel. Abnormal steel has a tendency to give a thin case of high-carbon content and to form soft troostitic spots in hardening.

3. The structure of normal and abnormal steel varies with the carburizing temperature and the rate of cooling. Carburizing tests on a laboratory scale can easily be made.

4. The variation in carburizing properties is caused by oxides uniformly distributed in solid solution in the steel. The ultimate cause is improper deoxidation of the steel when made, and no later treatment can change these properties.

5. The influence of the oxides in regard to grain size is theoretically explained by their influence on the solidification of the steel in the ingot and their later obstructing action against grain growth. Disintegration of the pearlite in the hyper-eutectoid zone is caused by the solution pressure from the oxides in solution in the ferrite.

6. The formation of soft troostitic spots in hardening of abnormal steel is explained by the action of the oxide particles as starting points for the troostite formation. This explanation is founded on the investigations of Portevin and Garvin on hardening of carbon steels.

7. The results obtained in heat treatment of all kinds of steels, notably high and medium carbon steel, is dependent on the presence of oxides in the steel, and many mysterious failures, especially in hardening, are likely to find their explanation by carburizing; and a miscroscopical examination of the structures obtained.

"Carburizing on a laboratory scale with microscopical examinations is

necessary to safeguard results and more than one specimen must be taken from each lot of steel. Tight fitting containers are imperative for successful laboratory work. The variation in carburizing properties is caused by oxides uniformly distributed in solid solution in the steel which have influenced the solidification of the steel in the ingot and later obstruct the grain growth action. These oxides likewise are starting points for soft spots. The results obtained in heat treatment of all kinds of steels, notably high and medium carbon, are influenced by the presence of oxides in the steel. Failures may be reduced, especially in hardening by carburizing and a microscopical examination of the structures obtained."

## Delegate Session

Tuesday afternoon at 2:00 o'clock Mr. T. D. Lynch called the delegates session to order and after roll call proceeded with the order of business outlined by the committee on arrangements.

## Symposium on Metallurgical Education

At 4:00 o'clock the Symposium on Metallurgical Education was held under the chairmanship of Prof. S. L. Goodale, University of Pittsburgh. The keynote of this symposium was "not how but what to teach." Several contributions in the form of written papers or discussions were presented before the meeting which resulted in much favorable comment by those present.

Mr. H. B. Knowlton presented a paper entitled "Education of Machinists and Tool Makers in Heat Treatment."

At the same hour 4:00 p. m. a round table discussion on heat treating was held under the chairmanship of Mr. H. J. Lawson of the Cadillac Motor Car Company, Detroit. This meeting was exceptionally well attended and the discussions which were brought out were very instructive and helpful to those who were fortunate enough to have attended the meeting.

## Annual Smoker

The annual smoker and entertainment was staged in the spacious auditorium of the General Motors Building at 9:30 p. m.

The program for this event was indeed well taken care of by the Detroit Chapter boys. They surely did themselves justice in their selection of entertaining features. Numerous athletic events were presented under the direction of Fielding H (Hurry-Up) Yost, Director of Intercollegiate Athletics and Dr. May, Director of Physical Education, University of Michigan. The athletic stunts, the vaudeville acts, the music, the refreshments and all were of the highest order and as evidenced by the enthusiasm of those present every one must have had an enjoyable evening.

## General Heat Treating Session

Wednesday morning at 10:00 o'clock the general heat treating problems session was called to order by J. Fletcher Harper, Research Engineer, Allis Chalmers Mfg. Co., West Allis, Wis., chairman.

The program for this session consisted of five papers, the first paper en-

titled "Heat Treating in Lead," by R. B. Schenck, metallurgist, Buick Motor Car Co., Flint, Mich., was presented by the author. Mr. Schenck's paper was printed in full in the September issue of TRANSACTIONS. A brief review of this paper is as follows:

The lead pot furnace has, in recent years, been applied to volume production in steel treating with considerable success. While molten lead is far from being an ideal heating medium, it is the only metal which can be successfully employed for this purpose; and in comparison with the salts in commercial use as bath materials, it has the advantage of a much wider range of working temperature and a much higher heat conductivity. These two properties permit the use of lead in units of very large capacity for temperatures of 650 to 1700 degrees Fahr., thus covering the hardening and tempering ranges of nearly all commercial steels.

The selection of pot materials, the design of the pots and brickwork, and the method of firing are points of prime importance and must receive considerable attention if efficient operation is to be obtained. The unit should be built for the job it is intended to handle, bearing in mind at the same time the desirability of standardization.

While some parts cannot be treated efficiently in lead, there are many which can be handled very successfully. Axle shafts, transmission gears and many smaller parts are now being hardened from lead pots, and a greater number are being tempered in lead. The lead furnace has its greatest range of usefulness for tempering operations, and many parts can be tempered in lead which cannot be efficiently quenched from this type of furnace.

Comparing the lead pot with the oven furnace from the standpoint of operation cost, a great deal depends on the nature of the work handled, but in general, it can be stated that for hardening, the oven furnace is the cheaper of the two, and for tempering, the costs are slightly in favor of the lead pot.

Taking everything into consideration, the greatest argument for the lead pot furnace is the high quality of the treated product resulting from uniform and accurate temperatures. It is very difficult, if not impossible, with an oven furnace to obtain the degree of uniformity which exists throughout a lead pot. Experience covering a period of years has proven, at least to the author's satisfaction, that where conditions permit of its use, the lead pot can produce consistently better work than any other form of heating unit.

The second paper "Furnace Atmospheres and Their Relation to Formation of Scale," by Mr. G. C. McCormick, assistant metallurgist, Crompton & Knowles Loom Works, Worcester, Mass., was read by Mr. V. E. Hillman, metallurgist with the Crompton & Knowles Loom Works.

This paper records experimental data and procedure during the investigation of the scaling activity of oxidizing, neutral and reducing atmospheres during the heat treatment of steel. The scale which was formed on low, medium and high carbon steels when heated to various temperatures and under varying conditions of furnace atmospheres, has been determined quantitatively. Under certain conditions, oxidizing neutral and reducing atmospheres permit of the formation of scale. This conclusion is supported by the data obtained and may dispel some popular misconceptions.

The third paper of this session entitled "Thermal Transformations of some Chrome Vanadium Steels" by J. S. Vanick metallurgist with the

Fixed Nitrogen Research Laboratory, Bureau of Standards, Washington, D. C., was presented by the author.

This paper described the effect of varying amounts of carbon, chromium and vanadium in a typical chrome-vanadium steel, upon the thermal transformations in the steel. The transformations occurring upon heating and cooling as well as the relation of these transformations to structure and hardness were discussed. This paper will appear in a later issue of TRANSACTIONS.

The fifth paper was presented by its author C. L. Ipsen, designing engineer, Industrial Heating Department, General Electric Co., Schenectady, N. Y., entitled "The Selection of Electrical Furnace for Steel Treating." Mr. Ipsen is recognized as an authority on electrical heating furnaces and presented some of the latest information and data in reference to them.

### Joint Meeting with the American Drop Forging Institute

At 2:00 p. m. Wednesday a joint meeting of the American Society for Steel Treating and the American Drop Forging Institute was called to order by the chairman. The first paper was presented by the author, Walter G. Merritt, of New York City, entitled "Some Fundamentals with Respect to the Labor Question." Mr. Merritt having had much experience as an organizer was in a position to speak with authority upon this timely subject.

Following Mr. Merritt's paper, Mr. Felix H. Levy, of New York City, delivered his paper entitled "The Menace of the Sherman Act to the Country, and How it Should be Amended."

Mr. Levy was Special Assistant to the Department of Justice under Theodore Roosevelt and has participated in many important proceedings under the Sherman Act. This paper was received with much interest and brought out many points which perhaps were not clear to many of Mr. Levy's audience.

Each of these worthy papers will be published later in TRANSACTIONS.

### Round Table Discussion

At 4:00 p. m. Mr. John J. Halbing, assistant superintendent of heat treating, Ingersoll Rand Co., Phillipsburg, N. J., called the practical round table discussion meeting to order. This meeting similar to the one held Tuesday, brought out many points of discussion and interest to those attending.

### Carnival, Frolic and Dance

As guests of the Detroit Chapter all those attending the convention were invited to attend the Carnival, Frolic and Dance held in the Auditorium of the General Motors Building. The party started about 9:30 p. m. and lasted until 1 a. m. A large number of persons were present and we are sure that all had a wonderfully fine time.

The hall was prettily decorated and lighted, the music was excellent and everyone was in the humor, consequently we all enjoyed a splendid evening.

### Tool Steel Session

Dr. C. M. Johnson, director of research, Crucible Steel Co. of America, Park Works, Pittsburgh, as chairman, opened the tool steel meeting at 10:00 a. m. Thursday. This was one of the most interesting sessions held.

Considerable interesting discussion followed each paper. Had it not been for the short amount of time assigned for the discussion of each paper, considerably more discussion would have resulted, as evidenced by the keen interest shown in these papers.

The program for this session consisted of four papers, the first of which was presented by Mr. H. J. French, physicist with the U. S. Bureau of Standards, entitled "Lathe Breakdown Tests of Some Modern High-Speed Tool Steels." This paper was written jointly by Mr. H. J. French and Mr. Jerome Strauss, chief chemist United States Naval Gun Factory.

The paper was an exhaustive report giving the results of hundreds of breakdown tests on high-speed steel lathe tools. This paper was published in September TRANSACTIONS. An abstract of it follows:

This report is concerned with comparisons of performance of modern high-speed tool steels in so-called "lathe breakdown tests," in which the endurance of tools is measured under definite working conditions, and likewise with the limitations of this method when applied to the purchase of steel. The modern steels are first classified according to chemical composition and this division made use of in discussion of results obtained.

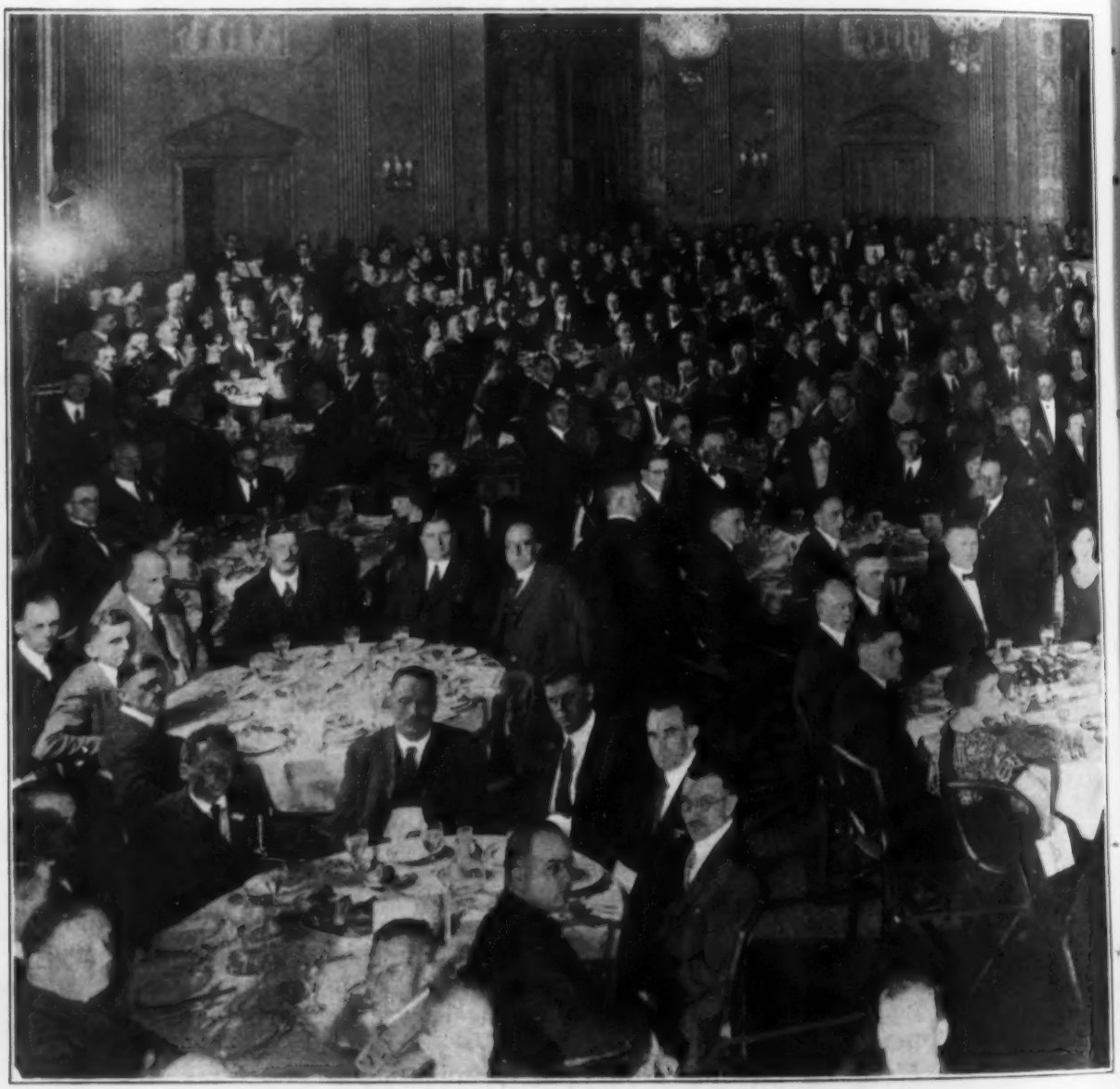
Important features developed or conclusions drawn may be summarized as follows:

1. Breakdown tests are not satisfactory as the basis of purchase for high-speed tool steels.
2. While competitive comparisons of brands of nearly similar performance are not justified, owing to the qualitative nature of this type of test, relatively large differences may be ascertained with certainty providing sufficient tools are tested and averages of at least 2 grinds are used in the interpretation of results.
3. In certain severe breakdown tests with roughing tools on 3 per cent nickel steel forgings, in which high frictional temperatures were produced, it was found that the performance of commercial low-tungsten high-vanadium and cobalt steel was superior to that of the high-tungsten low-vanadium type and special steel containing about ¼ per cent uranium or ¾ per cent molybdenum. The average power consumption in all cases was practically the same so that this factor need not be introduced in comparisons which may be made on the basis of endurance of the tools.
4. Modification in test conditions including small changes in tool angle but principally changes in cutting speed more markedly affected the performance of steel containing cobalt or special elements such as uranium or molybdenum than that of the basic types (plain chromium-tungsten-vanadium steels).
5. The relatively poor endurance of the high tungsten steels under severe working conditions was not observed in more moderate tests, made on the same test log with equal cutting speed and depth of cut but with reduced feed, in which the frictional temperatures produced were not so high. Also in these latter tests the performance of the cobalt steels was better than either the low or high tungsten steels.
6. Hardness determinations and examination of fractures indicate that the various types of commercial high-speed steel show differences in behavior under heat treatment and in physical properties

which probably are of importance under moderate working conditions, and might counterbalance slight advantages in performance.

The second paper was presented by Col. A. E. White, Director of Engineering Research, University of Michigan. His paper was entitled "Carbide Segregations in High-Speed Steel." In brief the author's paper pointed out that the degree of segregation in high-speed steel depends upon the casting temperature, the rate of cooling the ingot and the degree of mechanical reduction on the mills. He stated that the manufacturers of steel were cognizant of these controlling factors and that they are attemping to control them to eliminate as far as possible segregations in the final product.

The author stated that the time was ripe for experimental work in this field, along lines somewhat more drastic than had been the case in the past. The user of tool steels usually has given little attention to these matters,

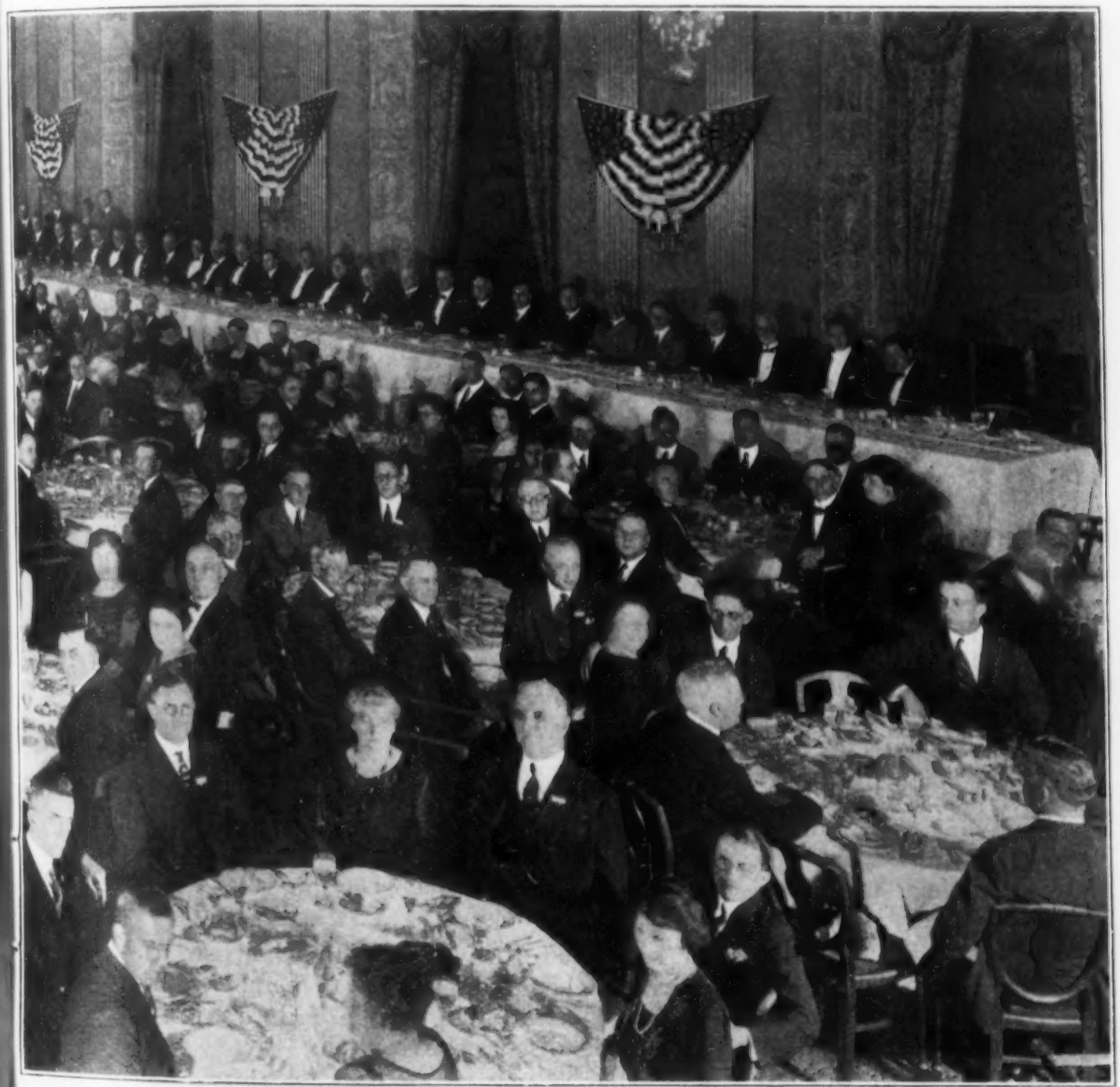


FOURTH ANNUAL BANQUET OF THE AMERICAN SOCIETY FOR

his attention being from a complaintive rather than a constructive standpoint. The useful life of a tool rests as much in the hands of the user as it does in the hands of the manufacturer. Its life depends upon many factors, chief among which are the proper form of cutting edge, the rate of feed and the speed at which either the tool or work is moving as well as the necessity of proper lubrication. Col. White indicated that the next few years will bring about fundamental improvements in the manufacture of high-speed steel and that it was necessary that the consumer and manufacturer work closely together.

Mr. J. V. Emmons, metallurgist, with the Cleveland Twist Drill Co., Cleveland, presented the third paper of this session entitled "The Effects of Structure Upon the Machining of Tool Steel." This paper was published in full in September TRANSACTIONS.

In brief Mr. Emmons' paper discusses the effect of the hardness and the



STEEL TREATING IN THE BALL ROOM, HOTEL STATLER, DETROIT

structure of tool steel upon its machinability. Detailed observations have been made of the effect of the various structural constituents upon its machinability. The machining operations considered are turning, milling, drilling, reaming, thread cutting, swaging wire drawing, punching and shearing.

General conclusions are drawn as to the most favorable structures for the various machining processes. Explanations of many of the difficulties encountered in machining tool steel are offered, and the way is pointed out for the development of annealing processes to secure the desired machinability.

Some very valuable and interesting discussion followed this paper. Considerable emphasis was laid upon the fact that brinell hardness was not necessarily a criterion as to the machinability of the steel. The printed discussion of the paper will appear in a later issue of TRANSACTIONS.

The fourth paper of the tool steel session was presented by the author, Dr. N. B. Hoffman, metallurgist with the Colonial Steel Co., of Pittsburgh. Dr. Hoffman's paper was entitled "A Metallographic Study of Hollow Drill Steel."

This paper gave a brief account of the severe duty that a hollow steel rock drill must withstand in everyday service. Until recently the material from which these drills were made was plain carbon steel. During the past 2 years attempts have been made to market alloy steels for this purpose, but the results have not been entirely satisfactory, owing to the fact that the steels were submitted to the blacksmith on the job in the field who were not equipped with proper means of heat treating these tools after forging, nor are they familiar with the characteristics of alloy steels. Dr. Hoffman's paper will be published later in TRANSACTIONS.

The last paper for this session was presented by the author, Mr. J. S. Vanick, metallurgist with the Fixed Nitrogen Research Laboratory, U. S. Bureau of Standards, Washington, D. C. The title of the paper was "The Deterioration of Steel and Wrought Iron in Hot Gaseous Ammonia."

## Dedication of Kelly Memorial Tablet

Thursday afternoon was the appointed time for the dedication ceremonies of the William Kelly Memorial Tablet erected at Wyandotte, Michigan. These ceremonies were witnessed by many members and guests of the society. The account of the occasion appears elsewhere in this issue of TRANSACTIONS.

Coincident with the dedication ceremonies a technical session was held in the General Motors Building. This meeting was called to order by the chairman, Mr. A. W. F. Green, chief of laboratory, with John Illingworth Steel Co., Philadelphia, Pa.

The paper scheduled for this meeting, entitled "Some Failures in Aircraft Plane and Engine Parts," by J. B. Johnson, Acting Chief, Material Section, War Department, Air Service, McCook Field, Dayton, O., and Samuel Daniels, metallurgist with the same service, Dayton, O., was presented by title.

As this was the only paper scheduled for this session, chairman Green suggested that instead of adjourning that the assembled members discuss several questions of importance in respect to the fatigue failure of metals. This was agreed to and a very valuable discussion resulted.

At 4:00 p. m. the last round table discussion on heat treating problems was held. The meeting was very well attended and much interesting discussion was developed.

## Annual Banquet

The annual banquet of the Society was held Thursday evening, October 5th, in the Ball Room of the Hotel Statler. This banquet was the largest in the history of the society. The American Drop Forging Institute and the Drop Forge Supply Association united with the American Society for Steel Treating on this occasion. At the speaker's table were seated the officers and guests of honor of each of the societies, including the past officers, the present and incoming ones. William C. Kelly, son of the William Kelly who was honored at Wyandotte earlier in the day, was present at the speaker's table.

President Gilligan, American Society for Steel Treating, was chairman of the evening, and after his opening address presented Charles T. Bragg, the toastmaster of the occasion.

Mr. Bragg proved to be a very capable and entertaining toastmaster. He presented Mayor Couzens, of Detroit, who made a short speech of welcome to the guests of Detroit. Following Mayor Couzens, Frank H. Alfred, President of the Pere Marquette railroad, presented a very able address entitled "What Is the Matter With the American Railroads Today?"

Mr. Alfred's address is published elsewhere in this issue of TRANSACTIONS.

A masterly address was delivered by Marion L. Burton, President of the University of Michigan, Ann Arbor, Michigan, entitled "That Mind of Yours." Dr. Burton, after drawing numerous word pictures and relating several anecdotes developed in a very forcible way the importance of man's mind to his own success and consequently to the success of the nation.

Dr. Burton's address is published on other pages in this issue of TRANSACTIONS.

Prior to the two principal addresses of the evening, W. H. Eisenman, National Secretary of the Society, presented Frank P. Gilligan, retiring president, with a gold watch and chain as a small token of the Society's appreciation for the untiring efforts he put forth in making his administration a successful and productive one.

On behalf of the Board of Directors of the Society, Col. A. E. White presented certificates of Founder Memberships to Messrs. Theodore E. Barker and William P. Woodside, each of whom were responsible for the organization of the two original societies which were brought together and made one—The American Society for Steel Treating.

## Friday Morning Technical Session

Chairman R. S. Archer, metallurgist with the Aluminum Company of America, Cleveland, O., called the morning technical session to order at 10:00 o'clock.

Two papers were scheduled for this session, the first entitled "Heat Treatment and Properties of Duralumin," by H. C. Knerr, metallurgist with the Naval Aircraft Factory, Philatelphia, Pa., was read by the chairman. Considerable interesting discussion followed the reading of this paper. Mr. Knerr's paper was published in the October issue of TRANSACTIONS. The discussions will be presented in TRANSACTIONS at a later date.

The second paper entitled "Rapid Graphitization of White Cast Iron and a Discussion of Resulting Products," by Dr. Anson Hayes, Professor

of Chemistry, and Prof. W. J. Diedricks, Asst. Prof. of Mechanical Engineering, each author being faculty members of Iowa State College.

Dr. Hayes presented his paper and brought out some important points on the rapid graphitization of cast iron. An interesting discussion followed the presentation of this paper and will appear in a future issue of the TRANSACTIONS, together with the paper.

## Symposium on Hardness Testing

One of the most interesting and important of the three symposiums held during the convention was the one dealing with hardness testing, which was presided over by Major A. E. Bellis, president, Bellis Heat Treating Co., New Haven, Conn. This symposium was under the direction of the Hardness Testing Committee of the National Research Council.

Major Bellis presented briefly the objects of the committee, commenting upon the results of investigations along this line. The questionnaire which appeared in September TRANSACTIONS had assisted in a material way in gathering data and ideas of other men. Following the introductory remarks of the chairman, Dr. H. P. Hollnagel, General Electric Co., Schenectady, N. Y., presented his paper entitled "Significance of Hardness Tests." Dr. Hollnagel pointed out that there was a great diversity of opinion as to just what "hardness" was. He stated that there are two classes of hardness, superficial and penetration. In discussing the numerous methods for determining hardness, he classified them as falling under the following:—scratch, resistance to wear, rebound, bending, penetration impact and deformation.

The second paper entitled "Hardness and Its Relation to Magnetic Properties," by Prof. R. S. Williams, Oberlin College, was presented by title.

## Research Session

Last year at the Indianapolis convention the first research symposium was held. This year the second one was scheduled with some very interesting papers presented by men who are regarded as authorities on the subject. The meeting was called to order at 2:00 p. m. by the chairman, Col. A. E. White, Director of the Department of Engineering Research, University of Michigan. The papers which were presented are as follows: "Research for Engineering Societies" by A. D. Flinn, chairman division of engineering, National Research Council, New York; "Government Research" by W. M. Corse, vice chairman division of engineering extension, National Research Council, Washington; "Some Fundamentals of Research" by F. O. Clements, division of research, General Motors Corporation, Dayton, Ohio, and "The Executive and Research" by Dr. John A. Mathews, president Crucible Steel Co. of America, New York.

Two of these papers appear in this issue of TRANSACTIONS.

## Plant Visitation

Many members and guests availed themselves of the opportunity of visiting several of the Detroit automobile plants throughout the week. A generous list of plants were open to the inspection of the members of the Society, chief among which were the following:

The Ford Motor Co., Highland Park Plant; the Ford Motor Co., River

Rouge Plant; the Cadillac Motor Car Co.; the Central Forge and Gear Co.; the Lincoln Motor Car Co.; the Detroit Steel Products Co.; the Detroit twist Drill Co.; and the Hudson Motor Car Co.

Automobiles were furnished by several of the automobile manufacturers in the city for the transportation of visitors to the various plants.

### Visiting Ladies Entertainment

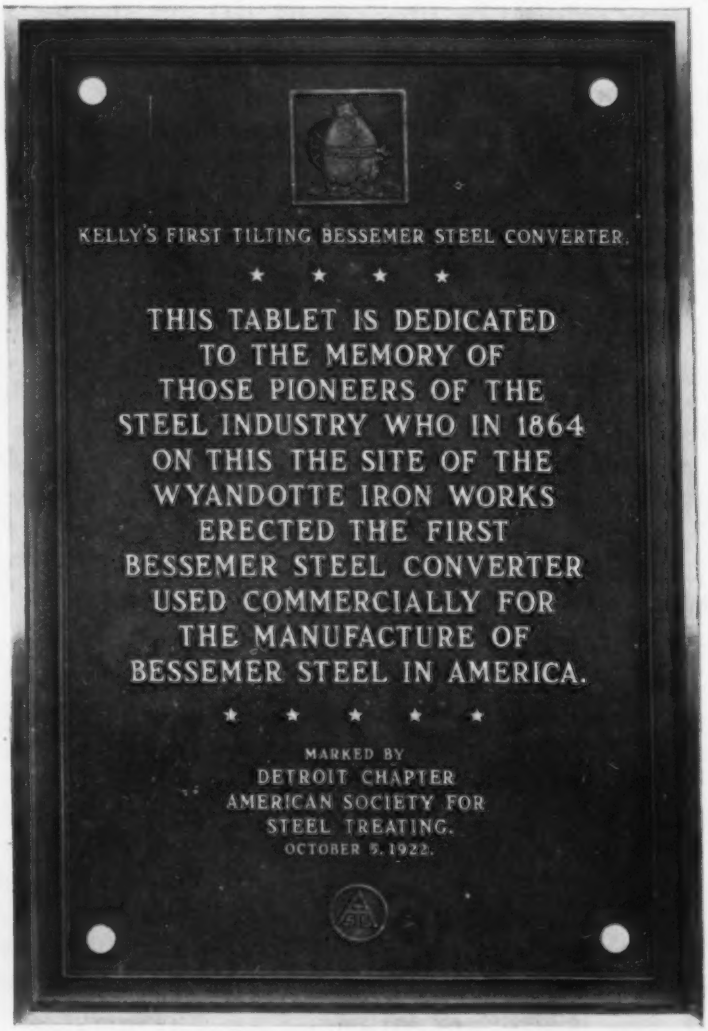
The visiting ladies were royally entertained during their stay in Detroit. The committee on arrangements had prepared a very interesting and attractive program which was enjoyed by upwards of 100 out-of-town ladies.

The first event was a luncheon held at the D. A. C. Tuesday noon, at which time the ladies were given the opportunity of meeting in a body. Each day was well occupied with motor trips, theatre parties, dancing parties and finally the annual banquet of the Society held Thursday evening in the Ball Room of the Statler Hotel.

From all of the reports we have heard, the ladies had a very enjoyable time while they were in the Auto City.

## THE DEDICATION OF BRONZE TABLET TO THE MEMORY OF WILLIAM KELLY

Thursday afternoon, October 5th, a rather large delegation of members and guests of the Society, proceeded to Wyandotte, Michigan, a city located on the Detroit river about 15 miles below Detroit, to participate in the dedication ceremonies of the bronze tablet to the memory of William Kelly, iron master and scientist, who is credited with being the first and the original




Courtesy of *Iron Age*

The Kelly Memorial Tablet

producer of steel in the United States by means of a pneumatic converter. The tablet was erected by the Detroit Chapter of the American Society for Steel Treating and is placed on the outside wall of the public library, which now stands on the site of the Wyandotte Iron Works where in 1864 William Kelly's first tilting converter operated.

The occasion was made a general holiday for the town. A parade of all school childen marched through the main street, headed by a large band, and assembled in front of the library for the ceremonial exercises. Several white-haired citizens of Wyandotte, the last of the workmen who had la-

bored in the plant where Kelly made his steel, were seated on the speaker's stand erected in front of the library.

Captain Robert W. Hunt of Chicago who in his earlier days had worked with William Kelly in developing his process and William C. Kelly of Charleston, W. Va., son of William Kelly were guests of honor who presented speeches during these ceremonies. Col. A. E. White, past president of the Society made the dedicatory address followed by the unveiling of the tablet.

The ceremonies were opened at 3:45 p. m. by J. L. McCloud, chairman of the Detroit Chapter who presented President Frank P. Gilligan, of the American Society for Steel Treating, master of ceremonies of the occasion.

### President Gilligan's Introduction

"It is an honor to preside at an occasion like this, arranged to recognize in a formal manner, and to perpetuate the memory of one of the industrial pioneers of this country. And in this connection I think it is only fitting to read a communication received from one of the steel pioneers of England, Sir Robert Hadfield:

**22, CARLTON HOUSE TERRACE,**

Dear Sir,

I notice that you have very thoughtfully decided to erect a tablet to commemorate the establishment of the first Bessemer Converter in America, on the site where Kelly's first tilting Bessemer Steel Converter was erected. I note this site is now occupied by the Wyandotte Public Library.

Provided the scheme is completed perhaps you will kindly let me have some printed matter about it, also photograph of the tablet with the wording, which I should like to have amongst my historical papers. If it is possible to send me two copies of the proceedings relating to the Unveiling exercises on October 5th, giving the speeches, and other information, I should be much obliged.

If this letter should reach you, previous to the exercises taking place, may I as an Englishman, and as one of the Honorary Members, offer heartiest congratulations on the greatness which William Kelly achieved in his pioneer work. All honor to such men.

With best wishes for the continued progress and prosperity of your Society.

Yours faithfully,

(Signed): R. A. HADFIELD

The Secretary,
American Society for Steel Treating,
Cleveland,
Ohio.

"It gives me pleasure to introduce the National President-elect of the American Society for Steel Treating, Mr. T. D. Lynch.

**Pres. Elect Lynch:** "Ladies and gentlemen, it certainly gives me great pleasure to appear before you, to honor a man whose honor is due him. William Kelly was an American scientist who completed his work in 1888, at the advanced age of 77. He wrought well and left an inheritance and a stepping stone for greater things. He was born in Pittsburgh, Pa., edu-

cated in the public schools, and spent his early life in that smoky city. At the age of 33 he moved to Lyon County, Kentucky, to work in the iron industries there. Being of an aggressive turn of mind and of research disposition, he began experiments on the important problem of reducing the fuel cost in the manufacture of iron and steel. This, in turn, led him to the study of the special problem of decarburizing molten iron by the air blast, which he accomplished in 1847. Mr. Kelly took out patents in this country in 1856 and built his first converter at Wyandotte on this ground in 1864. Here this great invention was demonstrated commercially, and here, by the courtesy of the Detroit Chapter of the American Society for Steel Treating, we, his followers, and with us one of his compatriots, Captain Hunt, who will speak to you later, have the pleasure of honoring him.

"The problem of steel making, like all other developments, has come to us in steps. One problem was solved, and then another; the molten iron refined from the ore and the bar forged from the nugget marked the beginning. Then came the crucible process of making steel, invented by Huntsman, a watchmaker, in 1742, to serve the special need for a material from which to make watch springs and tools. This process, while limited in quantity production, produced a steel the excellency of which hasn't been surpassed to this day.

"One hundred two years later, 1864, Mr. Kelly's converter process was demonstrated and the manufacture of converter steel on a quantity basis was begun, marking the beginning of the use of steel on an extensive scale, or the arrival of the age of steel.

"The open hearth and the electric furnace processes followed, and today steel is made commercially by all of these processes, varying in quality, carbon content and alloy elements. The limitless variety of merchantable steel available for various purposes, the proper thermal treatment for rendering this suitable for use, and the judicious application of these steels in design, together with their corresponding proper treatment, are problems of great importance. Our Society, the American Society for Steel Treating, has for its aim, and is working on, the solution of many of these problems by the exchange of experiences, free discussion of various treatments of different steels and the correlation of results, found both by experiment and in service, and desire to bring this data to the attention of the members of our society, and through them, by means of our printed publication—TRANSACTIONS, to educate the public, and thus do our part in harmonizing the science of heat treating steel for the benefit of mankind.

**President Gilligan:** "Prominent in that long list of leaders who have helped put this country in the first position are the names of Kelly, Jones, Hunt and innumerable others. Today we have the pleasure of Captain Hunt's company, and it gives me great pleasure to introduce him to you."

## Captain Hunt's Address

"Mr. Chairman, ladies and gentlemen, it is needless to say that I take great pleasure in being here, and I am also free to say to you that if it were not pointed out to me that this is the location of the steel plant with which I was connected many, many years ago, I should not have recognized it.

"It is 57 years since I first came to the experimental pneumatic—Kelly process-steel plant, located where we are today dedicating this tablet.

"Not relying upon my memory for the details of the Wyandotte Rolling

Mill Company's plant, as it then existed, I depend upon the American Iron & Steel Association's Directory of the Iron and Steel Works of the United States, and it is there stated that the Eureka Iron & Steel Company had two blast furnace stacks at Wyandotte, Michigan, furnace No. 1, built in 1855, was a stack of 50 feet by 12 feet and was rebuilt in 1884 and 1885, while furnace No. 2 was 45 feet by 9 feet, built in 1863, and was originally called the Ward Furnace.

"The two furnaces were built side by side, with their casting houses covered by one roof, and it was adjoining the casting house of No. 2 furnace, which was the southernmost of the two, that the experimental Kelly Process plant was built.

"The authority above quoted states that the rolling mills were built in 1855, with five double and five single puddling furnaces, 12 forge fires, 11 heating furnaces, 6 trains of rolls, 8, 10, 18, 20, 24 and 30 inches respectively, and one five-ton hammer. The products of the mills bearing the brand of 'Wyandotte' consisting of boiler plate, tank iron and merchant bars.

"The Swedes were among the earliest users of the pneumatic, or as they called it, the bessemer process, to achieve commercial success with it, this undoubtedly, was largely due to the low phosphorus and sulphur content of their ores, which were then smelted with charcoal, and used the iron directly from their blast furnaces for the conversion into steel by the bessemer process. Undoubtedly, the selection of Wyandotte for the location of the experimental steel plant was largely on account of the production there of charcoal pig iron from the pure and rich Lake Superior ores, and that belief is strengthened by the fact that the first iron to be treated in the steel plant was taken directly from the Eureka, or No. 1 blast furnace.

"Going back of the history of the steel plant, it is an interesting fact that, undoubtedly, Wyandotte was selected for the location of the blast furnaces and rolling mills because of the cheap water communication with the Lake Superior iron ore region, and the fact that the surrounding country was covered with desirable timber for the making of the charcoal to be used in the reduction of the ores. At all events, the furnaces did depend upon the supply of wood in this immediate locality, and it was following the exhaustion of that supply that their operations ceased."

"This is not the time to go into the complete history of the invention or the introduction of the manufacture in this country of steel made by the pneumatic or Kelly—Bessemer Process—now universally known as the Bessemer Process.

"This experimental plant was owned by Capt. E. B. Ward, of Detroit, the principal owner of the Wyandotte Iron Works, the Cambria Iron Company, Johnstown, Pa., Lyon Shorb & Company and Park Brothers & Company, of Pittsburgh, Pa., and Z. S. Durfee, and later Messrs. Chouteau, Harrison & Valle, of St. Louis, joined the combination, which was known as the Kelly Pneumatic Process Company, and was operating under U. S. patents which had been issued to William Kelly, of Eddyville, Ky. Later, they also secured Mushet's American patent on recarbonization, No. 17389, dated May 26, 1857, Letters Patent for the same having been taken out in England on September 28, 1856.

"It is historical that previous to the application of William Kelly for a patent, Henry Bessemer, of England, had taken out U. S. patents, dated February 16, 1856, and August 25, 1856. Subsequently Kelly claimed priority

in the discovery of the principles of the process, and our patent office allowed his claim by granting him patents.

"It was constructed under the supervision of Mr. William F. Durfee, a talented mechanical engineer, and from plans prepared by himself, and it was under his personal direction that the first heat of steel was made in the fall of 1864 from direct blast furnace metal, and it was the first heat of steel made in America by the pneumatic process, and it was also, of course, the first heat of such steel to be made in this country from direct blast furnace metal.

"Another experimental plant was built under the direction of A. L. Holley, in Troy, New York, for the firm of Winslow, Griswold & Holley, and based upon Bessemer's American patents, for process and machinery including the tilting converter, but they did not make a heat of steel until February 16, 1865, while Mr. Durfee, at the Wyandotte plant, had made his first blow in the preceding fall. The Troy conversion was of remelted pig iron Mr. Durfee soon had the assistance of Mr. Lewellen M. Hart, an Englishman, who had acquired some experience in the business at the works of Messrs. Petin, Gaudet & Company, in France. Upon Mr. Hart's recommenation, a reverberatory furnace was built for the purpose of melting pig iron for the charges to be used in the conversions, and mixtures of English and American irons were used. The works remained under Mr. Hart's direction

VIEW SHOWING THE CROWD WHICH ASSEMBLED IN FRONT OF THE WYANDOTTE PUBLIC LIB

until the beginning of 1865, when he severed his connection and went to the Troy works. He subsequently went to the Pennsylvania Steel works, at Harrisburg, Pa., and afterward engaged in other business in Philadelphia, where he died.

"In March, 1865, Mr. Ignatius Hahn assumed charge of the Wyandotte works. He had lately arrived from Prussia, where he had been in the works of Krupp, at Essen.

"Following my return from soldiering in 1865, to resume my duties for the Cambria Iron Company, at Johnstown, Pa., they decided to send me to the Wyandotte plant, so that I might prepare myself to take charge of a steel plant, if they determined to build one at Johnstown. This brought me here early in May, 1865. I reported to Messrs. Durfee and Hahn.

"There were many manufacturing difficulties encountered in the operation of the plant, particularly in the matter of refractories, tuyeres, etc. The 2½-ton converter did not have a removable bottom—Holley had not yet invented that improvement—and hence the vessel had to be cooled off sufficiently to allow workmen to crawl into it to repair a defective bottom or make a new one. Moreover, William F. Durfee had been much hampered in his construction plans by having to keep away as much as possible from anything controlled by the Troy Bessemer people. At all events, matters did not go

RARY TO HEAR THE MEMORIAL DEDICATION CEREMONIES IN HONOR OF WILLIAM KELLY

very smoothly, and Mr. Hahn, on July 4, 1865, unexpectedly and peremptorily resigned and left the place.

"Capt. Ward sent for me to come to his office in Detroit, and asked me if I thought I could run the place. I replied to him that I could, at least, do what, so far, I had only seen others do—make failures. He laughed and said, 'All right, go at it.'

"By some great good luck, my first blow on July 7th or 8th, 1865, was a successful one, and I stayed on the job until May 14, 1866, when the Cambria Company called me home to Johnstown, as they thought they were ready to commence the building of their own steel plant, but through various causes we did not get that plant started until July 10, 1871. Upon leaving Wyandotte, I turned over the management of the works to A. S. Aubrey, who had been connected with them during practically all of the time from their first building, and I believe he remained in charge until they were finally abandoned.

"Not only was the first heat of pneumatic steel to be made in America produced in the Wyandotte plant, but the first direct blast furnace metal to be converted in America was here treated. The first metal to be converted, which had been remelted in a cupola, was here blown, the metal having been melted in a cupola in a foundry belonging to the iron works, standing outside of the casting house of No. 2 blast furnace (this was under Z. S. Durfee's direction.) The metal was run in an open gutter to the converter, and hence became too cold for satisfactory conversion, but based upon the partial success then attained, it was decided to abandon the remelting air furnace and erect a McKenzie cupola, which was done in the fall of 1865, and while the regular supply of metal treated came directly from the blast furnace, the cupola was used to melt whatever irons were sent to the plant for trial.

"Another 'first' of great importance was the rolling of the first steel rails in this country in the iron rail mill of the North Chicago Rolling Mill Company, before a company of prominent iron and steel men, on May 24, 1865, from steel blooms hammered under the Wyandotte 5-ton steam hammer, from ingots cast in the experimental steel plant. These rails were subsequently laid in the track of the Chicago & Northwestern Railroad where they gave good service. There were not many of them, but they thoroughly demonstrated the practicability of American steel rails.

"Still another of the many 'firsts' to be made at the plant was the use of 'bottom casting' of ingots, and also the use of ingot moulds with the large end up. Many problems were met and most of them solved.

"A stationary converter was constructed in 1865 to avoid the Bessemer tilting converter patent. This was successfully tried, but about this time the patent controversy, between the Kelly Process Company and Winslow, Griswold and Holley was ended by a consolidation of the two interests in a new organization, in which the Troy or Bessemer people received 70 per cent and the Kelly, or Wyandotte people, 30 per cent. John A. Griswold, John F. Winslow and Daniel J. Morrell, being trustees, and Z. S. Durfee General Agent. This action cleared the business atmosphere and a number of licenses were taken and plants of larger capacity were rapidly erected. Captain Ward bought the Wyandotte experimental plant from his associates, but it was not adapted for commercial competition and was, in a comparatively short time abandoned. Moreover, Captain Ward was largely interested in the North Chicago Rolling Mill Company and that company built an up-to-date Bessemer plant which started operations in 1871. This plant, after many years of successful operation, was abandoned, the North Chicago Company transferring

the scene of their operations to South Chicago, the works there built being now a part of the United States Steel Corporation holdings. So has time brought many and great changes."

**President Gilligan:** "Among the many interesting contributions received by your committee, one from one of the prominent shipbuilders is of particular interest. 'It may interest your Mayor and his guests to know that the first steel steamer built in America was the tug boat Sport, built at

Col. A. E. White Unveiling the Kelly Memorial Tablet

Wyandotte in 1871-72 and that she was built of the steel products resulting from the experimental work which was not of sufficiently uniform character to be marketable. There was a pile of ingots in the mill yard which I had rolled into plate, from which I got more than enough good stuff to build the boat. I sold the surplus to the Detroit Safe Company. I saw the Sport in Port Huron a few years ago. She was 45 years old and in good condition.

Signed—FRANK KIRBY.'

"It gives me pleasure to introduce Col. A. E. White, past President of the American Society for Steel Treating, who will dedicate the tablet."

**Col. White:** "Mr. Chairman and guests, ladies and gentlemen, in behalf of the Detroit Chapter of the American Society for Steel Treating, it gives me pleasure to dedicate this tablet to the memory of those pioneers of the steel industry who, in 1864, on this, the site of the Wyandotte Iron Works, erected the first converter used commercially for the manufacture of steel. With deep appreciation that our present-day civilization is in no small measure built upon the work of such pioneers as William Kelly, whose son we are honored to have with us today. We bow in deep appreciation and gratitude to the memory of such a man, and acknowledge with full significance our debt because of his accomplishments.

"To you, Hubert Amiot, representative of the City of Wyandotte, we entrust the keeping of this tablet. May it remain throughout the coming generations as a memorial to the work and genius of Mr. William Kelly and

as a continual source of inspiration to the youth of America."

**President Gilligan:** "I am pleased to introduce a citizen whom you well know, His Honor, Mayor Amiot of Wyandotte."

**Mayor Amiot:** "Mr. Chairman and delegates of the American Society for Steel Treating, attending guests, and citizens: I am indeed honored in accepting on behalf of the City of Wyandotte this historical tablet which is placed here in remembrance of one of the things in past industrial history in Wyandotte, the first making of bessemer steel in America, of which our citizens are proud. In behalf of the city and in behalf of the iron and steel workers who are living and dead, and those who made Wyandotte their home, we further thank your organization for the honor you have done our city in showing their part in the iron and steel industry of this country. I thank you, your organization, your association, for this most fitting tribute."

**President Gilligan:** "We are particularly honored today in having with us William C. Kelly, the son of the William Kelly whom we honor."

## William C. Kelly's Address

"Mr. President and gentlemen, members of the American Society for Steel Treating, Mr. Mayor, and particularly Mr. Robert Hunt, a gentleman of world-wide reputation, I need not tell this audience, looking upon that tablet, that I feel inspired as no other occasion could affect me. There are others, though, besides William Kelly whose names I feel should be on that tablet, though don't accept that suggestion as a criticism of the tablet, men like Capt. E. B. Ward. I don't believe that his best friends knew what he was doing, and if I may be permitted to take your time, ladies and gentlemen, I am going to tell you what he did before I get through. It would scarcely be worth while for me to take up any of the time of this large audience in going into any of the history of the bessemer process. Others more able than I have told that story. But there is a story which I would like to take advantage of this occasion to tell, that is unknown to the world, it is a part of the story of the bessemer process, which I should call the pneumatic process. It is intwined with romance and tragedy, and I believe might be interesting to you. In as brief a way as possible I will tell you this story.

"William Kelly was in the dry goods business in Philadelphia, though he had made his lifelong study that of metallurgy. In those days the states throughout the country had their own individual financial and banking systems, every state had its banks; not all the banks put out their own money, and merchants in Philadelphia who were selling goods throughout the West had difficulties of collecting that we do not experience in these days. As a junior member of the firm of McShane & Kelly, he was sent out on a trip to collect the debts owing them in Western Pennsylvania, Tennessee, Kentucky and Indiana and Ohio, and when he had reached Nashville, Tenn., he was then through his trip. Now this large crowd of young ladies here suggest and inspire me to tell this story. When Mr. McCloud honored me with an invitation to be here, I didn't know exactly what the program was, and I have made no preparation to make any address, so what I have to say is only told you in a rambling manner. But as I look upon these young ladies here it reminds me of a romance connected with William Kelly's life which has never been told, and as a great believer in Providence, I think probably it had more to do with the discovery of the decarburizing of iron without the use of fuel than any one thing.

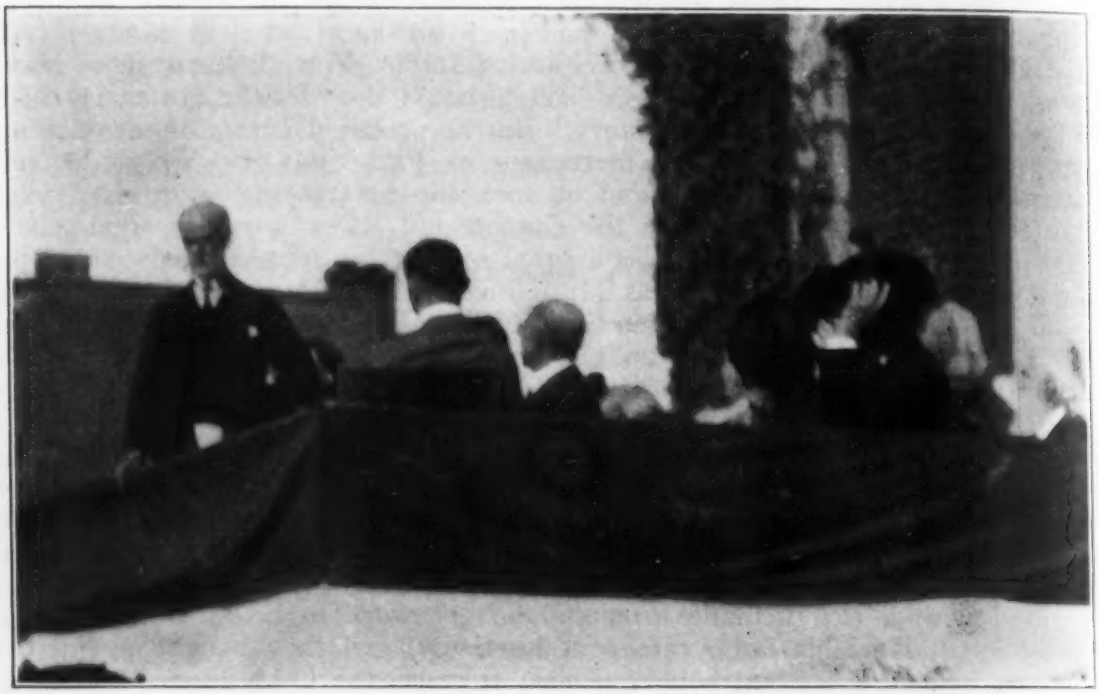
"After he had finished his business in Nashville, Tennessee, his friends wanted to entertain him, and the most interesting place to visit in Nashville, Tennessee was the female Academy. It happened to be the end of the school year and there was a graduating class marched out and placed on exhibition. Now William Kelly was considered an exceedingly handsome man, although none of his sons took after him, I am sorry to say. There were some 12 or 15 girls lined up, they were the graduating class, and in that crowd there was a little girl just sixteen years old, with her hair streaming down her back, and I presume she had on short dresses like you girls wear. Anyway it was a fateful moment for William Kelly. There she stood, an apparition of loveliness, and he had met his fate! I will not tell you the long story which usually follows such affairs. You all know more about that, and particularly you younger ladies, than I do. I have gotten so old I have forgotten that part of the story. But he procured letters of introduction from friends in Nashville to merchants in Eddyville, Ky. where he had learned the young lady lived, and he took the first steamboat to Eddyville. He found that a little town on the Cumberland River, a rather small place, 300 or 400 inhabitants, but it was a great market for tobacco, and one of the first gentlemen he met there was Mr. Gracey. Mr. Gracey lived part of his time in Eddyville and part of his time in New Orleans. He was a great tobacco merchant. He bought up all the tobacco around that country. Mr. Kelly took particular pains to get well acquainted with him and cultivate him because he expected to see that little girl coming down from Nashville in a few days, and he wanted to meet her again, and he wanted to be on the good side of her father. He spent some time there, and I understand he did a good deal of buggy riding around the country, and in the course of those rides, while I presume he was very much absorbed with the young lady, at the same time he took occasion to find that the whole face of the earth was covered with a rich hematite ore, and he got word to his brother John F. Kelly in Philadelphia, who came out hurriedly, and they bought up all the country around there and bought a blast furnace, the Cobb Furnace. Shortly afterward William Kelly was married to this young lady and settled there and built Sewanee Iron Works and Union Forge on the river.

"Now in those days they made iron with charcoal, they didn't use coke, and you can readily understand how, in a few years the timber was all cut out, so they had to go so far to get this timber that it became a losing proposition. And another thing that had a direct bearing on this process, the ore, the surface ore, had given out.

"Up to that time they could go along with a wagon and men and shovel it up from the ground into the wagon and take it to the furnace and melt it into metal. That had given out, and from a very prosperous beginning they began to lose money and bankruptcy was staring him in the face, principally on account of the ore and timber giving out. Now one day Mr. Kelly was passing along in front of the knobbling fires in the forge,—and these fires, understand, were operating by colored men, they were slaves. He noticed in one of the furnaces, that the charcoal which had previously been on the metal had all burned away, there was no fuel there, but air was being blown into the knobbling fire and the metal was boiling. He threw up his hands, he had been studying metallurgy, he know what oxygen and carbon mechanically combined meant, and he recognized that he had made a great discovery, that if brought into mechanical union, you would decarburize the metal and make it wrought iron, and he had made a great discovery.

"Now I feel somewhat embarrassed. This is the first time I have ever spoken except very privately, to anyone regarding the pneumatic process, and I do think that on this occasion there ought to be some truths told for the sake of history regardless of whom it may hurt, and I am going to do it, if you will just give me a few minutes. Although it was not my intention to make a speech here, I am going to tell you some truths about William Kelly and which he had requested to remain unrevealed during his lifetime.

"Captain Ward of this city, as you many of you know, especially you



William C. Kelly, Son of William Kelly, Delivering His Speech at Wyandotte

pioneers, had Mr. Durfee go to England. Henry Bessemer had brought out this pneumatic process, but Bessemer had never made any more of a success of it as a steel process than had William Kelly, who never did claim to have made a success of the process. All he ever claimed was he had discovered the operation of the run-out fire, though he had made claims as to what he could do if he had the opportunity. Mr. Durfee went to England. Bessemer had become enormously wealthy by the sale of rights to use his process for making steel.

"Now as a matter of fact, he had never made a success of it until Robert Mushet brought it to perfection. You gentlemen know all about Robert Mushet. I will not attempt to go into that in detail. But Mr. Durfee's mission to England was to see this process in operation and to buy the Mushet patent for the Kelly interests of this country, and when he came back to America the first thing he did was to visit my father at my home and in the course of conversation he pulled out a photograph and handed it to Mr. Kelly and he said, 'There is a photograph of Henry Bessemer.'

"Now let me tell you that during his experiments at Sewanee Iron Works there had suddenly come upon the ground two Englishmen. The Sewanee Iron Works was way back in the interior, practically in the wilderness. It

took three weeks to get from New York to Sewanee Iron Works, where you can now make it in eighteen hours.

"Now what brought those Englishmen to Sewanee Iron Works? Kelly & Company had agents in Cincinnati, Shreeves, Steele & Company. They were importers of steel and iron, and they were the agents of Kelly & Company. They had doubtless written over to England about Kelly's experiments and about his making run-out iron without the use of fuel. These Englishmen came upon the ground, one of them was a very intelligent man, and they stayed there some time and assisted Mr. Kelly in his experiments, trying to develop a process for making the iron, the pig metal into steel, for William Kelly had had this pneumatic process in operation at his forge for years before he ever attempted to take out any patent on it, he was trying to perfect it, which he never did, never claimed to have done, and trying to make a steel process out of it. When Durfee handed William Kelly this photograph he said, "Great God! Durfee, that is the man who helped me in my experiments at Sewanee.'

"Now William Kelly asked Durfee never to tell that, and I never knew it myself until a few years ago my mother told me of the incident that it was so humiliating to my father he didn't want it known that he had been duped, and whether he was mistaken in recognizing in that photograph that Bessemer was the man who had come over there secretly, under an assumed name and had learned and gotten his idea and took it back to England. Whether that is true or not, there were two Englishmen there, and when they left, they left at night, they didn't even say 'Good-bye.' They were traced up to New York and went directly back to England, and if it wasn't Henry Bessemer then,—well, I believe it was. And he believed it was, because there was no mistake about the face of Henry Bessemer, and I believe, as I stand here, that Henry Bessemer was the man that came to Eddyville, came to Sewanee, got that idea and went back and never carried it a bit further toward success than William Kelly; and the very way that he treated Robert Mushet, the man who made it a practical success, showed that he had a yellow streak in him.

"Now I am sorry to say that, but as I said in starting out, I intended to tell the truth, regardless of whom it might hurt. Everybody that knows the history of this case knows how ruthlessly Bessemer treated Mushet. It remained for Mushet to perfect the pneumatic converter and due credit should be given him. Mushet you know was an eminent metallurgist.

"Now I have taken up enough time, but all my life I have had the desire, if the opportunity ever came, to tell the truth about this thing. I could go along and tell you that when William Kelly discovered this thing, this method of blowing, it was called there Kelly's air blowing process, and people thought he was crazy. When he had first discovered this, the first thing he did was to go home and tell his wife, because she had heard his complaints for months that the timber was giving out and it was going to break him. When he went home one day and told her he had discovered how to run the run-out fires without the use of fuel, by simply blowing air through the metal, she thought he was crazy and she immediately dispatched their daughter to town to bring her father and mother and Dr. Higgins. But he was a chemist and he explained to them that oxygen and carbon produced fuel, and this operation took the carbon out of the metal and reduced it to wrought iron, and he wasn't crazy at all. And a few days ago, after having received an invitation to this meeting, I happened to pick up a little booklet written by Mr. Butler of Youngstown, and in his 'History of Fifty Years in Iron and

Steel' he tells how William Kelly, who, financially broke, went into bankruptcy on account of the ore giving out at Sewanee Iron Works. William Kelly at the time was trying to interest the steel men, the iron men of this country to develop this process. He went to Mr. Todd, I believe, of Niles, Ohio, if my memory serves me correctly, told his story and tried to interest him, spent a day there, had dinner with Mr. Todd, but after he left, Mr. Butler says that Mr. Todd remarked, 'That man is crazy.' And I dare say at that time nearly every iron man that he told the story to thought he was crazy. There was no opportunity, there was no chance, not a shadow of a chance, for William Kelly unless he could have developed and made his process a success himself to make steel, to ever interest an American iron man in it, because in those days the iron men were not surrounded by intelligent, high grade metallurgists to tell them what they were doing, as they are today. There was only one metallurgist at that time in the whole United States, Otto Worth of Pittsburgh, and it took two weeks to get from Sewanee to Pittsburgh to consult him, and it never occurred to Mr. Kelly to consult him, he didn't think it was necessary.

"I feel very much honored in being here today, but please understand, Mr. President, that I am not taking any of this to myself whatever; but when I look at that name there I feel that when this great body of scientific men have taken up this question and have emblazoned there on that tablet, they have done William Kelly justice, they have perpetuated the fact that he was the first inventor, or, as he termed it, (as William Kelly was not an inventor and never called it an invention) a discovery, a scientific discovery."

At the conclusion of Mr. Kelly's address President Gilligan thanked the assembly for their kind interest and co-operation in these ceremonies and all adjourned.

# WHAT IS THE MATTER WITH THE AMERICAN RAILROADS TODAY?

By F. H. Alfred

WHAT is the matter with the American railroads, you inquire. I counter with the query "Who is running the American railroads?" A few years ago the late Franklin K. Lane, upon his return from the International Railway Conference at Berne, Switzerland, said, "The conference established, beyond question, I think, the supremacy of the American railroads, from the standpoint of efficiency." This statement, from a student of American business, would indicate that from his viewpoint there was nothing wrong with the American railroads as compared with the railroads of other countries—and how else can we measure the efficiency of railroads except by comparing their operations with the operations of railroads of other countries. There was held in Washington last year, the great Disarmament Conference, having for its aim an economic rehabilitation of the governments of the world, and a readjustment of their relations, one with another—through the elimination of war and the waste connected therewith. The greatest economic waste in the operation of the railroads of this country is occasioned through the application of regulations of commissions, state and national. One thing responsible for the condition of the railroads that stands out most prominently is *over-regulation*. I shall endeavor to set forth, briefly, in what way our railroads are over-regulated:

1.—The Interstate Commerce Commission regulations
2.—Regulations through state commissions
3.—Transportation act, known as the Cummins-Esch act

## *Interstate Commerce Commission*

The Interstate Commerce Commission came into existence under a law passed in 1887. In 1908 when authority to regulate rates came into the hands of the commission, the average freight rate in the United States was 7.59 mills per ton per mile. These rates were reduced constantly until approximately 25 per cent of the entire railroad mileage of the country was forced into receivership. The rates reached the lowest stage in 1916 when they were, for the country, 7.07 mills per ton per mile. If I may refer for a moment to the Pere Marquette, as I want particularly to bring out the rate situation in Michigan, when that road was forced into receivership in 1907, its average freight rates were 5.9 mills, against an average for all roads in the United States of 7.59 mills, the average rate for all other roads being 29 per cent greater than the rates of the Pere Marquette. This road was again forced into receivership in April, 1912, when its average freight rates were 5.79 mills, as against an average throughout the country of 7.44 mills, being 29 per cent less than the average for all railroads of the country. The rates in Michigan have been lower than the average rates throughout the country since 1901, notwithstanding the higher cost of fuel and the hazards of winter operation.

The railroad executives in Michigan were successful, in 1917, in having this rate matter investigated by the Interstate Commerce Com-

A speech presented at the annual banquet of the Society in Detroit, October 5, 1922. The speaker, F. H. Alfred, is president of the Pere Marquette Railroad.

mission, as well as by the state commission, and as a result of the investigation, the Michigan zone rates were established. This zoning of the Lower Peninsula had the effect of bringing Michigan roads up to the average for the country as a whole. The result was most beneficial to the public, as well as to the railroads, for the Pere Marquette alone put back into its property over four times as much as the amount received from the increase in rates due to the zoning plan. The traffic representatives of the cities in our state, whose duties are to protect the manufacturing interests in their respective locations, have not been satisfied under the zone plan because of some increases brought about through this plan. They have been active before the Public Utilities Commission in repeated efforts again to break down our rates, which if successful, will, of course, result again in the breaking down of the transportation system in the state. The Michigan commission, in the summer of 1922, arbitrarily reduced the rates, intrastate, on sand, gravel, sugar beets and other commodities, making the rates on some of these commodities as low as the rates were in prewar times, notwithstanding that our costs of operation have not been correspondingly reduced. At a hearing before the Michigan commission in June, this year, I appeared and testified to the effect that the smaller railroads in Michigan were on the way and would soon arrive at bankruptcy. During the last year there were but two railroads in Michigan that made anything like a satisfactory showing in operation. One of the smaller roads, consisting of about 300 miles, went into receivership last year, and on Saturday last, another railroad, with mileage of about 100 miles, succumbed to the inevitable and asked our courts for a receiver. Another railroad, somewhat smaller, should be in the hands of a receiver at this time, and doubtless will be very soon. Unless some relief is afforded, other of the small railroads in the state will be forced into a similar situation. The members of our Utilities Commission should be, and doubtless are, students of economics, and they know as well as the railroad executives, the situation that confronts us.

The measure of success of railroads is dependent upon the three elements—rates, wages, and volume of business. Rates are in the hands of the commission, state and national. Wages are under the control of the Labor Board (except on small railroads under 100 miles in length). This leaves only, in the hands of the management, the volume of business, as a rudder to steer its course between Scylla and Charybdis.

Does the Interstate Commerce Commission's authority end with the rates, you inquire, or does that body have other authority over the operation of railroads? The commission has established a most elaborate system of reports and accounts. The law provides for all accounting to be kept under the requirements of the commission. Slason Thompson, Director of the Bureau of Railway News and Statistics, says the storerooms of the Interstate Commerce Commission are bursting with detailed reports for which it has no use. He has addressed the commission on the subject of "Waste in Clerical Service of the Railroads by reason of Accounting Requirements of the Commission." He shows that the number of clerks on railroads have increased in the past twenty-five years, 441 per cent as against an increase in all other railway em-

ployment of 137 per cent, the increase in clerks being three times as great as that of all other employes. He shows that if the commission will cut its statistical requirements one-third, it will save the railroads approximately $100,000,000, annually, and reduce the expenses of the commission by at least half a million dollars. Think of being able to save $100,000,000 per annum, which was 16 per cent of the net operating income of railroads of the country, on one item of accounting and still be able to function properly and furnish the commission with all the data that it should need. This amount of $100,000,000 per annum would buy fifty per cent of all the new box cars needed annually by all of the railroads of this country.

Does the authority of the Interstate Commerce Commission as applied to the operation of railroads, end here, you inquire. It does not. The commission, through a transportation officer, supervises, in a perfunctory manner, the physical operation of railroads. In times of stress, when one section of the country may suffer unduly by reason of shortage of equipment, or when there is danger of loss or suffering as in the handling of grain from the Northwest or fuel from the mining regions, the commission is empowered to take direct control of the situation.

Transportation is an evolution, perfected through continued operation, and cannot be disrupted as has been and is being done, without seriously impairing the service.

In every department of human affairs, practice long precedes science. Practice comes first in every new enterprise. Development, through scientific study, follows. Our understanding of economics is undergoing progressive development resulting from highly competitive business conditions. If there were no competition there would be little or no development.

With reference to the abandonment of unproductive lines. No line of railroad can be abandoned without the approval of the commission. It matters not how unimportant, or unnecessary, or how expensive the service may be, the operations must continue day after day until authority can be secured to discontinue. I consider this good practice and do not question the justice in the matter but securing the approval of the commission, even after the presentation of ample proofs, has been most difficult. I cite the case of a branch line on this railroad, six miles in length, running from Elmdale into the small village of Freeport. Six miles of branch line is a small piece of railroad to operate, particularly where there is no business. To require a service, six miles in length, to meet the passenger service on main lines, in this modern day with the automobile in such general use, and at a loss of $67,222 in two years and a half, equal to approximately $27,000 per year, or $4500 per mile, is wholly unwarranted. We are compelled to operate this line and to bear this continuing loss. Passenger traffic on the Pere Marquette railway, moving less than 25 miles, has decreased eighty per cent since 1916.

The Detroit Times, in commenting on the request of the Pennsylvania railroad to discontinue the service on the Barnegat Line, states that this explains the difference between public and private ownership; that public ownership considers the public needs—private

ownership, the stockholders dividends. The Post Office is owned by the public. How would it seem if private individuals owned it and discontinued all post offices in out of the way places that don't pay expenses? This is a very fair statement but does not go far enough. In the case of the Freeport Branch, if the people living at Freeport can be provided with a service that will take care of the needs of that community without assessing upon the business of the state $27,000 per year, it would seem that it should be done. The people must be educated to the fact that every unnecessary expense of a publicly controlled business (and without doubt railroads are wholly controlled by the government) must be paid out of the public pocketbook in one form or another. It is a misstatement to say that the money saved from this operation would go in dividends to the shareholders if the earnings exceeded 5½ per cent on the value of the property.

I have only referred to some of the powers of the commission as it affects the operation of railroads.

### *State Commissions*

In discussing the Interstate Commerce Commission regulations, I have made specific mention of regulations through state commissions, and will therefore not go into detail as to the powers of this body.

### *Transportation Act—Known as Cummins-Esch Act*

Under this act, which became effective on March 1, 1920, the Interstate Commerce Commission is charged with the duty of providing a system of rates that will yield a net return of 5½ per cent on the valuation of railroad properties as a whole, or in groups, as arbitrarily determined by the commission. There is no guaranty, but there is an inhibition against the possibility of earning more than 5½ per cent on a government valuation of railroad property. If any individual railroad does not earn 5½ per cent, it has no recourse under the law, but if it does earn more than 5½ per cent, one-half of the excess, under the provisions of this law, becomes the property of the government.

This act also provides for the creation of a Labor Board, the duty of which is to fix the rates of wages, rules, and working conditions, and adjust grievances that arise between the employes and the management. In adjusting the dispute between the management and the shop crafts, the Labor Board has been wholly unsuccessful. The shop crafts had accepted all favorable decisions of the Labor Board but refused to accept the decision of the board under which the wages were to be reduced 10 per cent, effective July 1, 1922, and declared a strike as of that date. The Labor Board called before it, at its headquarters in Chicago, on June 30th last, the executives of the railroads and grand officers of the shop crafts, in an endeavor to avert the threatened strike. The shop crafts were adamant in their refusal to abide by the decision of the board—the president of their combined organizations refused to appear before the board and refused to obey the board. On July 8th, the Labor Board adopted the following resolution:

"It must be conceded that the men who remain in the service, and those who enter it anew, are within their rights in accepting such employment; that they are not strikebreakers seeking to impose the arbitrary will of an employer on employes; that they have the moral, as well

as the legal right, to engage in such service of the American public to avoid interruption of indispensable railway transportation and that they are entitled to the protection of every department and branch of the government, state and national."

And on July 12, President Harding, in his proclamation, said:

"The maintained operation of the railways in interstate commerce and the transportation of the United States mails have necessitated the employment of men who choose to accept employment on the terms of the decision (of the Labor Board) and who have the same indisputable right to work that others have to decline work.

"Wherefore I am resolved to use all the powers of the government to maintain transportation and sustain the right of men to work."

Notwithstanding the firm stand taken by the Labor Board, and by the President the strike of the shop crafts has continued, with acts of violence and destruction of property which have made it necessary for the government to procure the issue of an injunction to protect the interests of the public in thus assuring continuous railroad operation. Further, notwithstanding this firm stand referred to, suggestions were made to the management of the various roads, by the President, that they take back all of the strikers except those guilty of destruction of property and personal violence, and give to them their seniority rights which they would have enjoyed had they not quit the service of the railroads. This the railroad managements refused to do by almost a unanimous vote, taking the position that they must of necessity protect the old men who remained loyal and the new men who came into the service after July 1st. The other labor unions, particularly the Big Four, composed of the men in train, engine, and switching service, undertook to bring pressure to bear upon the management to cause the return of these strikers with their full seniority rights. As a matter of fact, a number of roads have made compromise settlements with the shop crafts, under what is known as the Willard-Jewell agreement, whereby all the strikers are to be taken back into the service before October 15th, 1922. Some roads, on which few of the old men remained loyally in the service and where few men were hired, felt that they were warranted in settling under this compromise arrangement, whereas other roads, on which more of the old men remained loyally in the service and where large numbers of new men were employed under the guaranty of the management that they could be continued in the service as long as they complied with the rules and regulations, were not in a position to take on all of the strikers and have refused to do so. The sum of the loyal men in the service and of the new men that came into the service, together with the men who went out on strike, would increase the forces of the railroads in the country by over 100,000, or 25 per cent more than are normally employed in these departments. We do not feel we were warranted, in the first place, in sacrificing the principle that had been supported by the President and the Labor Board, and in the second place, in wasting money which should be employed in the betterment of service to the public.

### *Summary of Over-Regulations*

The impression seems to prevail quite generally that railroads are

now under private control, whereas, as a matter of fact, the railroad companies and their operations are, and have been, under public control for many years past. By public control I mean that control which, through regulation, has been placed in the state and federal commissions and in the United States Labor Board. In all important essentials, this control through public authority is, as stated, practically complete.

It covers:

A. The fixing of the carrier's rates for service through which its revenues are derived

B. The kind and character of equipment that shall be employed

C. The wages, rules, and working conditions of employes, for employes have only to disagree with the carriers as to such matters in order to obtain public control thereof

D. The financing of the carrier through the control of the issuance of securities

E. The accounting methods of the carriers

F. The terms of contract for transportation between the carriers and the shippers

G. Grade separations; train schedules; the use of terminals; the leasing of lands; the purchase, construction, sale or abandonment of tracks, etc.

All of the important incidents pertaining to the service of a railroad company which relate to the method of handling its property, or to the receipt or disbursement of its funds, are subject to state of federal regulatory and restrictive laws and orders, or both, which are often conflicting, and in the these conflicting orders, laws and regulations lie, to a great extent, the bane of the present system of public control. The average railroad official would not object to complete public control of the public service which his company performs, if the governing body, whether it be the Interstate Commerce Commission or any other organization, were required to carry the responsibility of such control and thereby to become answerable for the results thereof. Every railroad company has two great obligations to fulfill—first, its obligation to the general public in the performance of its service; second, its obligation to discharge its financial debts. As to the second obligation, it ought to be clear to any one that unless a railroad company is permitted to earn the necessary funds for the improvement of its service and for the discharge for its financial obligations and thus to maintain its credit, that the first mentioned service obligation will necessarily fail. The obstacles which now confront the railroads in their vain attempt to give the service which the public demands, are largely caused by the failure of congress and of the state legislatures, the federal and state commissions, in not co-ordinating their efforts, first of all, in the promulgation of a plan which will render railroad credit, at all times, stable and secure, so that by the use thereof, the demands which they are constantly making can be reasonably met. Instead of such co-operation, we find antagonism between the laws and regulations of the state and federal governments and often

between the states in their respective fields of control. For illustration, the Federal Valuation Bureau has undertaken to place a value upon the property of the railroads and under the transportation act the Interstate Commerce Commission is charged, for the first time, with the duty of providing a system of rates that will yield a net return of 5½ per cent on the aggregate valuation of railroads, which have been grouped for the purpose. The provision referred to, however, is unfortunately ineffectual and the efforts of the Interstate Commerce Commission to render it effective, are completely blocked by reason of certain other provisions of the transportation act which restored to the states, after September 1st, 1920, the power to charge intra-state rates. The states are now therefore attacking the rate schedules in effect prior to September 1st, 1920, without reference to the effect that the reduction of intra-state rates will have upon the fixed return of the carriers, without taking into consideration the value of the property dedicated to railroad service, and with a certain knowledge that such reduction will result in preventing the Interstate Commerce Commission from putting into effect, general schedules to insure the fixed return and to thereby aid the carriers in financing their present requirements.

*Impossible to Operate Industrials Under Railroad Restrictions*

Conceive Mr. Ford, in the operation of his interests, having the sale price of each automobile, truck and tractor manufactured by him, fixed by a government agency; that Mr. Ford had no power to increase this price regardless of the cost to him in producing the same; also assume that his plant must be kept continuously in operation without reference as to whether such operations are conducted at a profit or loss. Let us further suppose that a Government agency has fixed the rate of wages that shall be paid to every class of employee, and has established 186 shop rules and working conditions under which a mechanic, apprentice or helper would not be permitted to perform any service except as prescribed by the labor organization to which that individual belongs. Imagine further, if you can, that he is required to ship and market cars in a territory where they are not needed or used to any great extent, and where the people in the particular locality cannot afford to own, and do not pay for them, and that public authority had regulated his business with the intention that the loss on such cars must be borne by those who are purchasing his product in other portions of the country. Further let us assume that a government agency had determined that he shall not be permitted to earn more than 5½ per cent per annum, not upon the capital which he has wisely, economically, and honestly invested in his business, but upon an arbitrary valuation of his physical property, based on the findings of a group of men, many of whom may be classified as clerks, who have had no experience in the construction of large industrial plants, or personal knowledge of the cost thereof, and whose investigations and findings must necessarily, in large part, be based upon hearsay. Consider further that he is given no assurance, other than the broad statement in the law that the intention is to so fix the selling price of his cars, taken as a whole, that he will receive 5½ per cent upon this indirect, arbitary and unscientific method of valuation of his property; that if such 5½ per cent is not earned in any one year, it is his loss—

a loss which cannot be recouped under the provisions of the law, in subsequent years; that if he earns, by chance, more than 5½ per cent one-half of such excess must be turned over absolutely to the government, as its property, which amount would in turn be loaned by the government to his competitors in business, upon terms satisfactory to the government, and provided that they could furnish the necessary collateral security. Under such a condition of regulation, Mr. Ford's plant never would, and never could have been constructed, and if such regulations had become effective after the development of his plant, he could not continue his business with success, and this I say with all due respect to Mr. Ford, and in full recognition of the fact that he is a genius in business organization.

Let us now return to the railroad situation. The transportation act does provide that railroads as a whole, or in groups, shall be permitted to earn 5½ per cent, not on their invested capital, but on an arbitrary valuation of their entire physical property, fixed on findings made by a group of Government representatives, and tariffs have been established that would permit of this under normal conditions, yet, as a matter of fact, the railroads have not earned 5½ per cent on the valuation as fixed by the Government representatives, since the enactment of the law. The law became operative March 1st, 1920, upon the return of the railroads to the owners by the government. They actually earned, during the 10 months of 1920, 0.312 per cent; for the year 1921, 3.3 per cent, and for the first 7 months of 1922, 4.36 per cent, so that the railroads have not been able to earn, under the regulations of the Interstate Commerce Commission and the Labor Board, one fixing traffic rates and the other the wages of the men, 5½ per cent on the government's valuation of the property. This is only one of the regulations, but I believe you will agree with me that it would be unnecessary for me to mention any other. However, I must, at this time draw to your attention, other regulations which, while not as serious as the one mentioned, are exceedingly burdensome.

### *Relation of Employer to Employe*

No particular qualification seems to be necessary to admit men in every walk of life to assert, with authority, their views on the pros and cons of unionized labor. If unionized labor in its present form is a good thing for the country, why is it that it is gaining strength only in public and quasi-public controlled industry where competition is not keen? Why is it that the great majority of the privately owned industries maintain an open shop? My theory is that the laws regulating the relations between the railroad and its employes should be repealed and that the only exactions put upon the railroad in connection with the handling of its labor, should be the necessary protection to insure safe, sanitary and humane conditions. The wages should be regulated entirely by the law of supply and demand, just as they are regulated in other lines of industry, and should be in line with the rates paid by other lines of industry in the same territory, for the same class of employment. I think no one would deny the right of labor to organize to protect itself to this extent and it should be the duty of the public to see such regulation is provided that will secure to every working man, surroundings that are safe, sanitary and humane.

Under the union plan it is the job that is unionized and not the ability or worth of the man. A standard day's work is established that overpays the incompetent and makes a sluggard of the adroit worker. No one can establish a competence who does not make a conscientious effort.

Under our Constitution all men are born equal but they do not continue equal. Bishop Thomas Nicholson of Chicago said—"The wage worker will never be satisfied with higher wages and shorter hours any more than you or I will be satisfied with more profits and a better house. Things never did satisfy anyone, and never will. Satisfaction and contentment are matters of religion. Communities and industries, where motives are paramount, have no serious troubles." There is no solution for unemployment except by increased production and yet the unions are keeping their members, and others, from work by the thousands, all over our fair land. The worker is completely under the domination of his union, to the dwarfing of his own opportunity. Alexander Hamilton said—"Give all power to the many and they will oppress the few; give all power to the few and they will oppress the many. Both, therefore, ought to have the power that each may defend itself against the other."

The McAdoo administration of railroads will be recorded as the most costly and destructive agency, resulting in the greatest tax burden that has been inflicted upon the people of the United States since the Civil War. The heritage of the railroad owners, as a result of government control, is a 100 per cent unionized plant, with esprit de corps of employes at zero. The system of public control now in effect is ridiculous, indefensible impossible. The hands of railroad managers are bound. Unless congress takes up this serious situation and furnishes the relief which it alone apparently has power to grant, federal operation must again be undertaken and the tax payers of the country will bear its burdens.

*Remedy*

The old school management must succumb to new methods and men with power to incorporate into transportation the most modern business methods. Steam railroads have been the forerunners of civilization in this country and in Canada. Great courage was manifested by the men who extended the ribbons of steel across the plains and through the Rockies, in advance of requirement from a commercial view point. The rails of some of these roads are not yet filled with traffic. Have the arteries in the East expanded with the necessary rapidity in providing additional main tracks and terminals to handle, at all times, the seasonal business of the country? If not, have provisions been made to warehouse business that could not be moved to furnish protection to the producer? My heart goes out to the fruit grower and farmer, who is obliged to sell his product on a glutted market which always means a lower price, because no provision is made for warehousing. Why should the railroads not receive encouragement, through rates, to provide warehouses for storing grain and produce and pre-cooling stations for storing fruit, and allow the shipper the use of these facilities for a charge to cover interest on investment and upkeep? This would help to avoid congestions that occur annually on railroads, and at the

same time save the farmer many a heartache. Why do railroads not prevail on wholesalers to locate on the tracks of the company, where goods can be unloaded and re-shipments made in the same cars? If we have laws that will not permit of practices in the interest of the farmers, fruit growers, etc., then it is our duty to help to secure such modification as will permit of these vital economies. To my personal knowledge, there have been blockades on railroads, making embargoes necessary every fall, for the last twenty years. The same thing occurs year after year and nothing done to remedy the situation.

The improvement in steam locomotives have been practically nil during the last decade. Changes were made from the slide valve to the piston valve a few years ago and it is now a question as to whether the slide valve is not a better valve than the piston except for the fact that superheat could not be applied with the slide valve. The Walschearet gear that was applied to our locomotives a few years ago, was patented about 1850. We continue to weld flues in about the same old way and with the result that leaky engines are constantly with us. The automobile men have, in twenty years, developed a machine that seems to be about as simple, fool-proof and perfect as man need want. Why cannot the railroads more nearly perfect their equipment? About the only change we have made in passenger coaches is to double the car weight per passenger by building battleship coaches. If we would set about to overcome the journal friction, a saving worth while could be made in the cost of operation.

The reason for this situation is that the railroad managers have, in consequence of the numerous heavy penalties required by law, been obliged to give first attention to the numberless restrictive regulations of the public governing bodies,—the state and federal commissions.

Marked improvement is also possible through a revision of union rules that will eliminate 90 per cent of them. The same old stuff is incorporated in rules year after year, never taking out but always adding to, until some of the rules are, in themselves, so confusing that even the ones responsible for them cannot interpret them. I recall having given six months continuous time to making new schedules with employes of one railroad.

Why were the commissions given so much power? Judge Cooley, in his first report as Chairman of the Interstate Commerce Commission said:

"This act to regulate commerce was not passed to injure any interests, but to conserve and protect them. It had for its object, the regulation of a vast business according to the requirements of justice."

Under the Act of 1920, the duties of the commission were to conserve and protect the resources of railways that they may provide the service required by the public. If the Interstate Commerce Commission could function under the interpretation of its duties as outlined by Judge Cooley, the first chairman of the commission, it would seem the railroad situation would clear itself. Railroads have continued to function and improve in spite of the opposition of the general public. The performance of the railroads in handling the present volume of business, which is as great as has ever been handled in the history of the

(*Continued on page* 238)

# THAT MIND OF YOURS

By Marion L. Burton

TONIGHT I am going to speak upon something which concerns every person in the room, a subject of which every one of you, I believe, has a part, however small it may be, and in regard to which, if you have the faintest glimmer of intelligence, every one of you ought to have some convictions. It is a subject which is just wrapped and shrouded in mystery and that is the reason I can talk about it so long. But, nevertheless, it is a subject in regard to which there is something that is very important for men and women, it bears more specifically upon your personal success, probably, than any other single factor with which you deal, it has more to do with the efficiency of your shop, or of your office, or of your corporation, than anything that I could discuss tonight—it is more profoundly important for the administration of every municipality and for the administration of the government of the United States than anything with which I could deal, and it is absolutely and unqualifiedly inevitable if we are to solve some of the problems which confront mankind and civilization at the present hour.

The subject upon which I want to speak is—*That Mind of Yours.*

I said to you that the whole thing is wrapped and shrouded in mystery. I wish there were time tonight for me to discuss with you very briefly what might be called the Emergence of the Human Mind. I might begin by telling you that probably in the first croakings of the frogs we had the first glimpse of mental intelligence. I wish there was time to trace it from the amoebas and the frogs, the fishes and the birds clear up to the monkeys and ourselves, but there isn't time to do that tonight. I wish there were time just to illustrate to you where we come to the point, possibly, where there is the dawn of reason in this marvelously fascinating and evolving thing we call animal life.

I wish I could tell you about a creature over in the zoo in London so much like some college students that it is almost impossible for me to think she hasn't been registered in some of our American institutions of higher learning. She goes by the name of Sally. The teacher was trying to see if Sally could learn how to count and he would say to Sally, "Sally, give me two straws." And Sally would pick up a straw and put it in her mouth, and then she would pick up a second straw and put in her mouth and hand the two straws to the teacher. Then the teacher would say, "Now, Sally, I want five straws." And Sally would go through the same process and would give him five straws. But, like the average mind of the average undergraduate in American colleges and universities, if there was any attempt made to go above five straws, Sally didn't like it. And if you asked for six or seven or ten straws, she would take a straw and bend it so two ends would show instead of one, and thereby attempt to get away with the proposition. To me there is nothing quite so fascinating besides American public audiences as a cage fully of monkeys. When you think of their restlessness, their inquisitiveness, have you ever watched cages of monkeys, have you ever seen how they are alert every minute to take in what is going on in their environment? How they are never satisfied with the experiments they have made, but are constantly investigating one another and the universe of which they are a part? Have you ever stopped to think

A speech presented at the annual banquet of the Society in Detroit, October 5, 1922. The speaker, Dr. Marion L. Burton, is president of the University of Michigan, Ann Arbor, Michigan.

that in that fascinating little animal we have a hint that there is something finer and better, after all, to come out of this animal kingdom than we have yet seen.

They tell the story of a polar bear, I don't know where he was, it doesn't make any difference, but they used to throw buns to him and he would jump into the water and swim over and get the bun in his mouth. But finally they threw so many of them he didn't have time to swim after each individual bun, but he learned that if he would stay on the rock and take his paw and scoop the water like that (illustrating) it would cause little waves on the water and make the bun float over to him. I wish we could all get up to that high type of intelligence—*That Mind of Yours.*

And now there is just one other thing I want to say before I begin—there may be in this room tonight some of you who have studied the newer problems of psychology and of psycho-analysis. Some of you may be thinking a good deal these days about the whole problem of the unconscious element in our minds. I suppose the best psychologists today would concede that in these things of ours that we call minds there are at least three distinct layers. The mind doesn't dwell in any place, but there is that that might be called the upper layer, that you and I are perfectly conscious of. Those of you who are awake now are conscious of the fellow with red hair who is trying to make a speech to you. That represents the upper layer. Suppose I should stop and say, "Who was President of the United States before Mr. Harding?" After a time somebody would say, "I recall who it was." That represents another layer in your mind. That is the thing that is available. Somebody can ask you a question of something that you hadn't thought of for thirty, forty or fifty years possibly, and you could say after a while "Why, yes, this is it."

Then way back below that the sub-conscious, the layer or element which recent psychological discoveries have proven, probably has more to do with our conscious behavior than any other part of our mind.

Now I hope I have just given you a hint that the whole problem of the mind is shrouded and wrapped in mystery, yet an island of certainty upon which you and I can stand and which demands of us, if we lay claim to the high and royal prerogative of American citizenship, to see to it that that mind of yours is just as fine and splendid as it is possible for you to make it.

## *The Primacy of the Mind*

Having said that, maybe I will begin. The first point that I want to get to you is this: you won't like the word, I don't like it, but I have not been able to find a better word—I want very briefly to get to you this point of view with regard to this subject, *That Mind of Yours.* First of all, I want to get to you what I call the Primacy of the Mind, the *Primacy of The Mind.* You say, "What do you mean by that?" Well, I mean the unqualified importance of the mind. I mean its significance for everything that you and I do. Now if there were a lot of time tonight I think I could demonstrate to you that the mind is the one thing which, above all else, conditions your own personal success. There are men in this room tonight who think that success is not conditioned upon brain power, who think it is determined by luck or by friendship, or by personal pull, or by large amounts of money; but let me say to you this, that beyond any fear of successful contradiction I believe that human progress has been largely

mental progress, and every time you find for me a man with a brain, stored with facts, capable of thinking about the relationship of those facts, that there is a man who will have a first class opportunity to make his contribution to the solution of the problems of his generation. A man with a mind counts today anywhere in the world, and there never has been a generation when he has counted quite so much as the generation in which you and I have been given to live. That is one thing. Knowledge is power. Socrates was right. Now don't misunderstand me—I don't mean to say it is the whole thing. I am perfectly well aware of the fact that mere theorizing, simple ratiocination, mere intellectualism, doesn't always get you very far. But what I am trying to say is that it lies at the basis of the thing, and that along with that mind, if yours is the kind of thing it ought to be—if you have even the facility for developing a short circuit now and then and getting a little of the human quality into your relationships, you are almost irresistible in dealing with the unprecedented problems of this generation.

You see what I mean. We must reckon on the other things that we call the human element to make the mind what it ought to be. But a man who is mere good nature, simply the personification of good will, who thinks that by diplomacy alone he can do the task, is unwise, for we are only going to arrive at the solution of the problem with clear headed people working to sound conclusions, based upon indisputable facts, based upon our problems. The man who expects to succeed in any task today, in your factory, in your office, in your organization, any man, anywhere, must first of all get something to going on right up here. When you do that you have gotten into the most fascinating thing there is about life.

I wonder how many of you ever heard the story of the three pigs down in Texas.

These three pigs, little brother pigs, were born down in the state of Texas. And you can find this recorded in one of the scientific experiment bulletins of the state of Texas for the year 1916. They decided to make an experiment upon these three brother pigs and they named them Tom, Dick and Harry. They put Tom in a pen and gave Tom a scientifically balanced diet, containing just the proper amount of carbohydrates, proteids, fats guaranteed to satisfy the palate of the most fastidious pig, and they said to Tom, "We beg of you to partake of this diet, ad libitum, ad infinitum, ad nauseam. The result of this part of the experiment was that at the end of six months Tom had gained 94 pounds and he was not worth as much in the open market as was the food he had eaten.

They took Dick, put him in the same kind of a pen, gave him the same balanced diet, followed the same directions all the way through as they had with Tom, with this exception, they gave him some alfalfa which he was permitted to nose and eat, and at the end of the same six months he had gained 200 pounds, and he was worth a great deal more in the open market than the food he had consumed in that interval.

Then they took Harry, put him in the same kind of a pen, with the same kind of a diet, plus the alfalfa, plus an open gate through which Harry was permitted to enter a pasture and to roam and to root as he saw fit, and at the end of the same six months Harry had gained 312 pounds.

QUERY: Is education something that you hand down, or dig up? You

have a right to occupy some spot on the earth just in proportion that you have something going on up here. The only way you can learn anything is with an active mind. Queer sort of a conclusion isn't it?

Now I am trying to say something about the primacy of the mind. Do I need to repeat here what you have heard so often, and which you can never hear too frequently? Namely, upon a high level of intelligence depends the future of this American Democracy, and if America is to realize upon her invested hopes and aspirations, it must be because she has an intelligent citizenship. Intellectual incompetency may be satisfactory for Russia, but I beg of you to remember that if America is to win in her great experiment of Democracy, she can only do it because that mind of hers is what it ought to be.

And there is another thing. If there were time tonight to sketch the history of the last three hundred years with regard to human progress, I think you could agree with me speedily that human progress everywhere has always waited upon science, upon discovery, and if you and I are to be worthy of our generation, as men have been worthy of theirs in the past, we must see to it that this world of ours is mastered, and that the human race escapes from old tyrannies and new, because men with minds, day by day, and hour by hour, are seeing to it that the unsolved problems of mankind have brought to bear upon them that intelligence and mental power which will solve them. Yes, progress waits for it. And as I have already hinted twice, there never has been a time when there was such demand for mind power as there is at the present moment. The world today is just bristling with opportunities for the man who can think, for the man who knows, for the man who has some comprehension of what this marvelous, fascinating thing is that we call life. Do you see? And if there were time I would discuss these problems with you just briefly, not for the purpose of solving them, but merely by way of illustration. You know the natural sciences, in the last half century particularly, have put to shame all the other departments of learning, but we have come now to the point where all the social sciences, like economics and government, psychology, anthropology, all the sciences that deal with civilization and man, and some adequate comprehension of where man is going, these too must come forward with similar conclusions.

I wish I had the time tonight to discuss the relationships of capital and labor and some of the problems that President Alfred of the Pere Marquette has referred to tonight with his experience. I wish I could discuss with you what, to my mind, is probably the most vital problem before this generation, namely, our relationship to the rest of the world. You know if we are going to get back to normalcy, if we are going really to establish financial prosperity in this country, have an international trade that will get us anywhere, sooner or later we must come to recognize that the future of America depends upon the peace and the future of Europe, Central Europe and the East, and all the rest of the world. Whether we like it or are aware of it or are prepared for it or not, the fact remains America can never realize her ideals or come back to that period of general prosperity and stability which we all crave at this hour until in some way we get ourselves related in the right way to the rest of the world. Now I am not talking about a league of nations, I am not talking about an association of nations, I am not talking about this or that particular solution, although I would if there were time; but I am absolutely sure of one thing, that anybody who understands what

has happened to civilization and to Europe in the last six or seven years realizes, with the possible single exception of the British Empire there is not a solvent nation in Europe today. France is spending twice what she receives, Italy is tripling her budget, even Holland and Switzerland and Sweden have gone beyond their budgets. When you think of the disruption of transportation and the breaking up of manufacturing, the millions and millions of people that are living in chaos today, then I say to you there is no possibility of our getting back to normalcy until America assumes her normal obligations to the rest of mankind.

And I go North and South, East and West, all over this country, and I think I have a certain facility for finding out what men are thinking, and I am perfectly sure of one thing, and that is this, that America is ready now to accept her normal obligations to the rest of the world.

Now having said all of this only by way of hint to have you see the problems with which we are dealing, and therefore the inescapable necessity for what I have called that mind of yours, the primacy of mind—if you can get intelligence into yourself, into your office, into your organization, think of the problems that you can solve and of the contribution you can make to the prosperity of the United States of America.

### *The Receptive Mind*

My second main point is this: If we are going to think about that mind of yours, it may be helpful and interesting to think for just a moment about various types of minds. Again I wish I had an hour just to discuss these things, but I will just hint at them. As I do, just try to practice some introspection, without becoming too morbid. Try to decide, if you have one, what kind of a one you have. Now I wonder how many of you have read enough of philosophy to remember there was once a man who spoke of the mind as a *tabula rasa*, that is to say, just a plain, blank tablet, upon which things could be written. I am of the impression that multitudes of persons have just that type of mind, a thing upon which anybody can write anything. When I studied biology I used to poke the back leg of a frog and it would kick like that (illustrating) just when you poked it. There are multitudes of people who respond instantaneously to every external stimulus, they swallow it whole and never even have intellectual indigestion. They are the people who are so credulous, they are the people who make it possible for other people to say such absurd things, that would be so if they were true. They are particularly expert in the acceptance of all kinds of rumors, and the less likely the thing is to be true, the more glibly they take it in. You know them. I sometimes think this is one of the curses of America, that you can say some things which obviously are impossible, and yet some people will believe them, they are so receptive and credulous that anything that you write on the tablet of their minds just goes right down in and is received with a great and hearty welcome. Have you that kind of a mind? If so, you are not a citizen.

### *The Independent Mind*

Then there is another type, the man who has a mind of his own, he is interested, he knows how to listen, he knows how to weigh evidence; more than that, when he listens he doesn't pay so much attention to what people say as to what they mean. Now you men who are executives and presidents,

you know what I mean. I don't pay so much attention to what a man says when he comes into my office, I am particularly interested in what he says without knowing he said it.

Do you know they tell of Herbert Spencer, this incident—when a new book was presented to him he would always approach it with the cold, intellectual question, "Is it true?" I am not minimizing that ideal, mark you, in fact, I am in a way talking about it. But they say of Maurice, the founder of the broad church party, that when a new line of thought was presented to him, he always asked this question, "What does it mean?" That is what you and I must do with regard to some of the things that are being said about us, and all the organizations and agencies that make up what we call our government, we must listen and weigh evidence, but we must have minds of our own in interpreting the evidence. We must be able to take these things and think them through. A man is not an encyclopedia, you can never make a life by a haphazard, ill-considered jumbling of everything that life, in its richness, is trying to hurl at you. No. A man thinks, he weighs evidence, he sees the relationship of these things, he comes to conclusions independently. Here are two types of minds. Which kind have you, the receptive, or the independent?

### *The Conservative Mind*

Take another contrast, there is the conservative, the man who has the defect of imagining that truth knows time distinctions, that is to say, that a thing is true because it is old or new. He has the defect, too, of idealizing too much the past, but he has the merit of capitalizing his experience or believing in a stabilized, continuous world.

### *The Radical Mind*

Then there is the radical. It is awfully dangerous to speak about a radical today, because he has so many different shades of red and pink. Some of them sit with torses that are trimmed in red and blue and pink, and think they think they think. They disrespect the past. They have the fatal facility of identifying realities and truth with the changing terminologies of differing generations.

On the other hand, the radical has been of real benefit to us. He has idealized the future, even though he may neglect the plain duties of the present. More than that, he has sometimes been identified with progress. So we want to be very sure we catch his truth and that we attack his error. You here—which are you, are you the conservative, or are you the radical? When I talk to students I always like to poke a little fun at them about their radicalism. Students are the most conservative people in the world, although they believe themselves to be the most radical. Let something happen twice, and it is a tradition. There is always a little group of them who are perfectly sure that monogamy and capitalism and all the other things that you and I have accepted as pretty good answers to the permanent problems of civilization, are all wrong. The only thing I beg of you to remember is not to take them too seriously, to keep your sense of proportion and your sense of humor. Life is always too serious to be taken too seriously.

### *The Critical Mind*

And now, there are just one or two other types of minds that I might allude to. There is what we might call the critical mind—I mean the man

who is a real critic, whose mind is open to the truth, a man whose mind is free, who, for one instant, will not recognize any authority save the truth, and that which accords with the normal standards of experience, the man who frankly admits that all about him is mystery, problems that have not been solved, who realizes that every thinking person doubts at times, and therefore, who feels the glory and the fascination and the challenge of life just in this, that all about him are things that need to be solved.

Somebody, centuries ago, evolved the figure which Emanuel Kant made use of 100 years ago, "The World of Knowledge might be compared to an Island of Certainty, with its Border of Belief, and its great Ocean of the Unknown." We forget the beautiful shore and the solid rock upon which our feet are standing. Yet there is the critical mind that ought to take into consideration all of these things.

### *The Creative Mind*

Then there is the creative mind. Oh, I beg of you, I beg of you to use any influence you have to keep alive any spark of originality that you see anywhere, but don't be disturbed if it comes in unconventional forms, but if you see somebody who is trying to do something that never has been done before, if you cannot help him, please stand by with your head bowed in sympathetic silence, for what America needs is creative minds, minds which can dig, minds which can work, minds which have initiative, minds which can create the answers to the problems with which you and I are baffled today.

What kind of a mind are you bringing to your work, to yourself, to your family, to your office, to your organization, to your community, and to the world, What kind of a mind is it, that mind of yours?

Now, men and women, would you care to have me tell you what I imagine to be a pretty ideal type of mind, whatever your own immediate circumstances? Now there are a good many things that I might say that you ought not to do but I am going to be very positive, and forget all of that, and say this—that I am of the impression that however much of native endowment you may possess, whatever the psychological measurers might tell you if you went in and had yourself tested, I am of the impression that the finest thing that I could say to you would be this, that you must have a thinking mind. You know that Emerson once asked, "What is the most difficult thing in the world?" And his answer was, "To think." And the difficulty with Americans today is this, that we are so prone to accept things upon authority; if we see something in a newspaper, it is true—you know how it is. It is true largely because a lot of other people know the same thing.

Now don't misunderstand me. I think our newspapers today are infinitely better than they were ten years ago, and there is no group of people in our community that is striving harder to do what they ought to do, I believe, than our newspapermen. But take even our most carefully prepared scientific books—how many of you, as you read a book and look at the printed pages as you see them there, conclude that they must be true—have you ever stopped to think that you can take any of these books and find mistakes on every page of them? Probably the only reasons that men write scientific books is that other men can find mistakes and then write better books.

We must be extremely careful to recognize the overwhelming difficulties confronted by the person who proposes to think. What are some of the

difficulties you are going to run into? Oh, how I would like to tear your mind to shreds tonight if there were time. You run into two or three things that you are not, as a rule, conscious of. The first problem that you will have if you are going to have a thinking mind are those prejudices that you are constantly clinging to. How you cling to an idea just because it happens to benefit you personally. Have you stopped to think how you cling to ideas that you have had without any thought of where you got got them, or whether they are true or not? Have you stopped to think of how you oppose other ideas just because you don't know anything about them, and particularly how you oppose ideas because somebody in your group got the idea before you did? You remember, therefore, if he thought of it first, it is not true. And have you ever stopped to think of the remarkable facility that that mind of yours has to forget every idea that you come in contact with that you are opposed to? If you run into an idea that you don't like, you just cast it aside like that, without every stopping to examine it. Your big problem, if you are going to have a thinking mind, is the problem of thinking in spite of your prejudices, for every one of us is tempted to pre-judge a case on the basis of partial information.

### *Popularity Should Not Influence Your Thinking*

There is another thing, and that is not only thinking and your prejudices, but thinking and this question of popularity. You know how we are all highly sensitive to the judgment of our colleagues. You know I am very sensitive to what other university presidents think about what I do, and you are very sensitive as to what other people think of what you do. We want to be popular. There is nothing so fatal to your thinking as the desire to be popular. Have you ever stopped to think that if you are going to think, base your judgments upon facts, you cannot be concerned at all about whether your ideas are popular or unpopular? Any public servant, any executive officer, any man who expects to count in this generation, must completely forget whether a thing is popular or unpopular, and ask himself, "Is it in accord with the unescapable facts of the issue with which I deal?" That is the only way that you can think, and, whether popularity is right or wrong, the thinking person will not be concerned overmuch about popularity. For what is popularity? It is just what a good many people happen to think casually.

Would you like a little chapter out of my experience, a very brief one? When I want to really find out something that is important, I don't go to a faculty meeting to find it out. Why, you know I can remember when I was president of another educational institution of higher learning in the East, and we had a faculty meeting in which a member had been urged to make a motion before the meeting. In the meeting he made the motion, talked against it, and voted for it. Now I don't think much of conclusions that come out of that kind of deliberation, but if I want to find out something that I think is sound, and upon which we can place dependence, I say to professors A, B, X, and Y, "Come in, I want to have a little talk with you," and when our minds have met. I have the judgment that what we come to a conclusion upon is right. It is not popularity that will count in your thinking. You cannot get a thinking mind that way.

Just one thing more about the thinking mind. The thinking mind is the one that just has the time of its life with problems. Most of you people run

away from problems, you don't like them, but the thinking person is the one who every time he sees a problem tries to hit it on the head, writes it right down, lives with it, never runs away from it until he gets the answer. Lots of people like to state problems, and, like Pilate of old, who said, "What is Truth?" run off without waiting to find the answer. That is the trouble with much of our American thinking. We don't take our problems and go right through them for the facts. What is the trouble with American public life today? It is, that we base our public decisions, not upon the facts, but we base them upon popularity, upon opinions and upon the noisy invocations and inflections of certain types of demagogues. I go so far as to say that if we are to arrive at satisfactory solutions of public problems such as the one with which President Alfred has been dealing tonight, that we will do it, not by creating commissions to regulate them, but we will do it by employing the best trained, most scientific minds of the country in that field and give them a commission to set before us the facts in such terms that a student in the sixth grade of the public school could understand what their conclusions are. The trouble with the American railways tonight is that the public doesn't know what they ought to know about them. The trouble is that these decisions are made, not on the basis of scientific facts such as were given to us tonight, but on the basis of all kinds of policies and currents and cross currents that have little to do with the actual welfare of the American people. And if you and I are to be worthy citizens of a democracy we must insist, first, upon getting facts.

Tonight in the City of Detroit there are twenty centers from which are going doctrines and ideas and points of view diametrically opposed to the things which you and I believe the Constitution of the United States of America stands for. What are you and I doing about it? First, are we finding out the facts which lead some of these people to think what they do think? Secondly, are we trying to find out what they mean? And thirdly, if we have the facts, are we insisting upon wise and timely legislation in keeping with the facts?

Now you know when I ride in these smoking compartments of Pullman cars somebody always brings up the questions that concern our international problems with these nations. I am not discussing the labor question now. And then I always say, when a man tells exactly what we ought to do with this or that problem, "Why don't we do it?" He says, "Don't you know why? Because it would be contrary to the interests of this group or this corporation or this class of society or this particular organization or this state or this region of the country"—and what I stand here to say to you tonight is this, that that mind of yours must be a thinking mind in that it demands solutions of our problems and the knowledge of the facts, and when it has them, that it shall then insist upon legislation, regardless of the consequences to any individual or group or class, so long as the welfare of the public in America is concerned.

Now I am almost done. What have I said? My first point was the primacy of your mind. My second point was the various types of minds, and just a hint as to what type of mind you thought you had. My third point was that probably the ideal type of mind for a citizen is the thinking mind, which will deal wisely with prejudices and with popularity and with problems.

My general question is this: How are you going to do it? How are you and you and you going to master your mind? It is the most precious

thing that you possess, and what are you doing about it? Sixty-six million people every week go to the moving picture shows. Now don't misunderstand me, I go too, so does my wife, sometimes she prefers to go to them to listening to my speeches. But as I heard somebody say recently, the moving picture show never embarrasses ones intellectuality.

And what is it I am trying to come to? With all the seriousness which I can command, it is this, that you, of our self-respecting citizens are going to insist upon it that you know a little something of the mastery of your own mind.

Now, again, let me say that it is difficult thus to forget the unit of personality, to say the mind acts on the body and the body acts on the mind, and nobody knows how it is done. I beg of you never to forget that you are a unit and not a mind and a will and a heart and all the rest, you are one thing. Therefore, this body of yours must have the right kind of sleep, the right kind of exercise and the right kind of food, and all the rest, and the right kind of mental hygiene too. The thing I want to come to is this, I imagine that every executive in this audience tonight has a budget for the corporation of which he is the head. I know that we have one at the University of Michigan. We set the limits. That budget expresses our policies. It shows us how we are going to spend our income, and it makes room also for a certain amount of flexibility. You have your financial budgets for your homes, you women, and all the rest of you, but I want to ask you this question: Have you, as an individual, a time budget? Have you set any policies for the use of your time? How many minutes a day are you actually insisting shall be used for the cultivation of this thing which, after all, will determine more than anything else your success and your usefulness? What are you doing about it? Are you actually reading, and when you are reading, do you read, or do you slide? When you listen, as to me tonight, do you think about the next bridge party or how you should have played a certain card, or how you ought to have played that thing on the ninth hole, or do you actually try to think what the man means by what he is attempting to say? Do you know how to listen? When you are with your friends, what do they mean to you? Are they time killers? Is the time used for idle gossip, or is there a reasonable, normal amount of thought exchanged? Do you know what mental grip is? Mental application? Do you know what it is to settle right down to the grind until you go right through a problem and not around it? If you do, I know why you are President, or why you are Secretary-Treasurer, or why you are one of the dominating influences in a great organization that is affecting the commerce of America today. It is because you have something with which you can think, and you know how to use it, and to train it, and to hold it in leash. No man will master his mind who hasn't strength of character. No mind is worth while that isn't a clean mind, and honest mind, a mind that has honor, that is straight and true and veracious in its thinking. That is what we must have, that type of mind, that is not influenced by wrong considerations and wrong motives and constantly thrown off its balance by this inevitable tendency to deflect towards selfishness. The only way you are going to get it is to take that mind in hand and make it the kind of a mind that you mean it to be.

I am not forgetting all the things to which I have alluded in recent psychological discoveries, but all of them concede that, granted you have what

you have, you can make more of it than you are doing today. The thing that I have come here to say to you tonight as business men of intelligence, the thing that I plead for, not only in education, but in your own individual work in your community, in your homes, in this nation, is this, that we can bring intelligence to bear upon the solution of all our problems. It means that day by day you must supplement that mind of yours, it means there must be mental spaciousness that can take in the thing that the world is trying to say, all of its unformulated, unmeditated, unexpressed yearnings and emotions that mankind today is feeling, and that is sweeping through civilization as a whole. These things you ought to sense and trace out and drag out of the air and make a part of yourself.

Men and women, the thing for which I plead tonight is a new emphasis in your work and in your life, and emphasis upon what I conceive to be the most precious asset that you possess, that mind of yours, and I am of the impression that in proportion as we take life seriously, in proportion as we are determined to grow and to evolve and to be better tomorrow than we are today, in that proportion are we going to give attention to that mind of yours, for "As a man thinketh in his heart, so is he."

# THE MECHANICAL PROPERTIES OF SOME CHROME-VANADIUM STEELS

*Abstract*

*This paper deals primarily with the mechanical properties of chrome-vanadium steels for the purpose of obtaining information which would have a practical value in the design and construction of apparatus in nitrogen-fixation equipment.*

*The tensile properties, hardness and microscopic structure as affected by different heat treatments were determined for a given series of chrome-vanadium steels. The series selected lends itself readily to a classification based upon changes in the concentration of carbon, vanadium and chromium.*

*It was found that in the carbon series, containing from .15 to 1.20 per cent carbon, 1.0 per cent chromium and .18 per cent vanadium, in the annealed state, an improved tensile strength and a lowered ductility resulted with an increase in carbon content. With heat treated specimens a similar effect occurred up to .60 per cent carbon. A rise in hardness accompanied the increase in strength.*

*The vanadium series, containing .30-.40 per cent carbon, 1.0 per cent chromium and from 0 to .65 vanadium, in the annealed state showed an improvement in toughness over the corresponding carbon-chromium series. The tensile strength was only slightly affected. Heat treatment developed an improvement in the tensile strength and hardness. Ductility falls off rapidly when the vanadium content exceeds .30 per cent. High reduction in area which is maintained over the entire group of vanadium steels reveals the the toughness or inherent ductility of this type of steel.*

*The chromium series, containing .30-.40 per cent carbon, .18 per cent vanadium and 0 to 14.5 per cent chromium, in the annealed state showed the tensile strength and hardness to remain quite uniform for increases in chromium content up to 2 per cent. In excess of 2 per cent, chromium increases the strength and hardness at the expense of ductility. Heat treatment intensifies the effects of chromium indicated in the annealed specimens.*

*The relation between mechanical properties and the addition of varying proportions of carbon, chromium and vanadium on the microstructure were observed.*

## Introduction

THE superior resistance to deterioration of chrome-vanadium forging steel of the type containing .30-.40 per cent carbon, 1.0 per cent chromium and .18-.20 per cent vanadium, over ordinary carbon steels in important parts of the equipment used in the manufacture of synthetic ammonia by the Haber Process[2], led to an extended investigation of the mechanical properties of a number of special steels which contained these two important alloying ele-

1. Published by permission of the Director, Fixed Nitrogen Research Laboratory, U. S. Dept. of Agriculture.

A paper presented before the Society. The author, J. S. Vanick, is metallurgist, Fixed Nitrogen Research Laboratory, U. S. Department of Agriculture, Washington, D. C.

ments[3]. Much of the work was undertaken for the purpose of obtaining information which would have a practical value in the design and construction of important units in the nitrogen-fixation equipment. The data presented in this paper were selected from an extensive series of laboratory tests which were made in preparing the steels for corrosion and servic tests.

Since chromium and vanadium improved the corrosion resisting properties of the alloy steel over ordinary carbon steel, it was thought desirable to determine the influence of various quantities of these two alloying elements upon an ordinary forging steel. With this in view, two series of alloys were outlined in which either the chromium or vanadium content was varied while the carbon content was maintained as nearly constant as possible. A third series of alloys was added, in which the chromium and vanadium contents were maintained while the carbon content was varied. Thus 3 series of steels were built; a carbon series in which carbon was varied from .15 to 1.20 per cent; a vanadium series in which vanadium was varied from 0.0 to 0.65 per cent, and a chromium series in which chromium was varied from 0.0 to 15.0 per cent. This wide range in the latter was chosen in order that steels of the commercially designated *stainless* type, might be included. The compositions[4] finally obtained are recorded in Table I.

Chrome-vanadium steels of the 1.0 per cent chromium and .18 per cent vanadium type are obtainable commercially, in varying carbon contents. Steels 2 and 3 of the carbon series, containing .30 and .58 carbon respectively were so obtained. These two steels were prepared by electric furnace process, cast into 9-inch square ingots, cogged down to 5-inch square billets and rolled into 1-inch round bars. The remaining steels were made by drawing 600 to 700 pounds of metal into a ladle and adding the necessary ferro-alloys. After allowing a reasonable time for the solution and diffusion of the addition, the metal was cast into 5-inch square ingots and subsequently rolled into 1-inch round bars. All of the bars were given an annealing treatment by heating to 1500 degrees Fahr. and cooling in the furnace.

All tensile tests[5] were made on the standard .505 inch diameter threaded specimen. In a few tests the proportional limit was determined by employing an extensometer. In most tests, the yield point was determined by the use of dividers and the 'drop of the beam.' Hardness was measured by the standard Brinell and scleroscope methods. Impact tests were made with a Charpy machine on the standard specimen, notched 5 millimeters with the 'U' type of notch.

## Carbon Series

The mechanical properties of several steels varying in carbon and containing approximately 1.0 per cent chromium and .18 per cent vanadium,

2. The Direct Synthetic Ammonia Process. Jour. Ind. and Eng. Chemistry, 12, No. 9, Sept., 1920, p. 844.

3. The work described in this paper, represents a part of a larger program undertaken jointly by the Fixed Nitrogen Research Laboratory of U. S. Dept. of Agriculture, Bureau of Standards, and the Nitrate Division and Technical Staff of the War Dept. Credit is due Capt. E. Y. Titus and Dr. C. W. Bray of the Fixed Nitrogen Res. Lab. for initiating the study of the resistance to deterioration of various steels, in ammonia and its component gases, and for some of the preliminary work leading to the selection of some of the steels, described in this paper.

4. Acknowledgment is due H. A. Bright, Associate Chemist, Bureau of Standards, for the chemical analyses listed in this table.

5. Tensile and impact tests were under the direction of R. S. Johnson, Engineer-physicist at the Bureau of Standards.

have been described by Sankey and Smith (1, 2, 3)*, Griffiths (4) and others (5, 6). In each case the particular composition and heat-treatment of the steel must be considered. The advantage in tensile properties which the chromium vanadium steels possess over similar carbon steels has been quite generally conceded. The value of the alloys for most industrial purposes lies in the improvement they lend, when properly heat-treated, to the strength and toughness of the steels.

### *Annealed Steels*

The effect of carbon upon the tensile, hardness and impact properties is shown in Fig. 1. These properties represent the condition of the steel

**Table I**

**Composition of Steels**

| Number | C | Mn | P | S | Si | Cr | V |
|---|---|---|---|---|---|---|---|
| | | | Carbon Series *Part A* | | | | |
| 1 | .16 | .55 | .023 | .023 | .34 | 1.03 | .20 |
| *2 | .30 | .68 | .012 | .024 | .26 | .93 | .18 |
| 3 | .58 | .68 | .011 | .017 | .23 | .73 | .18 |
| 4 | 1.16 | .55 | .022 | .018 | .20 | 1.06 | .20 |
| | | | Vanadium Series *Part B* | | | | |
| 1 | .40 | .53 | .018 | .023 | .18 | 1.05 | .02 |
| 2 | .37 | .52 | .018 | .018 | .20 | 1.05 | .07 |
| 3 | .35 | .37 | .020 | .013 | .20 | 1.02 | .14 |
| *4 | .30 | .68 | .012 | .024 | .26 | .93 | .18 |
| 5 | .37 | .55 | .018 | .019 | .18 | 1.07 | .31 |
| 6 | .27 | .34 | .025 | .011 | .29 | 1.24 | .65 |
| | | | Chromium Series *Part C* | | | | |
| 1 | .38 | .39 | .017 | .022 | .27 | .04 | .19 |
| 2 | .29 | .53 | .015 | .011 | .16 | .51 | .28 |
| *3 | .30 | .68 | .012 | .024 | .26 | .93 | .18 |
| 4 | .31 | .48 | .011 | .011 | .12 | 2.01 | .34 |
| 5 | .33 | .37 | .028 | .013 | .26 | 7.70 | .18 |
| 6 | .42 | .35 | .025 | .009 | .06 | 14.40 | .18 |

* A commercial type of chrome-vanadium steel about which the compositions of the remaining alloys were built.

after an 8-hour anneal at 1500 degrees. Fahr. The increase in tensile strength and hardness accompanied by a decrease in ductility and greater brittleness as measured by the impact tests agrees in general with the well-known influence of carbon upon these properties. The connection between the properties indicating strength and those indicating ductility and toughness obeys the familiar inverse relation; the ductility falling off rapidly as the tensile strength rises with the increase in carbon. The tensile properties of the alloy steels compared to those of the corresponding carbon steels hold their advantage over the latter, through the range of carbon, investigated. The advantage is slight for the lower carbon steels, but increases rapidly with the increase in carbon.

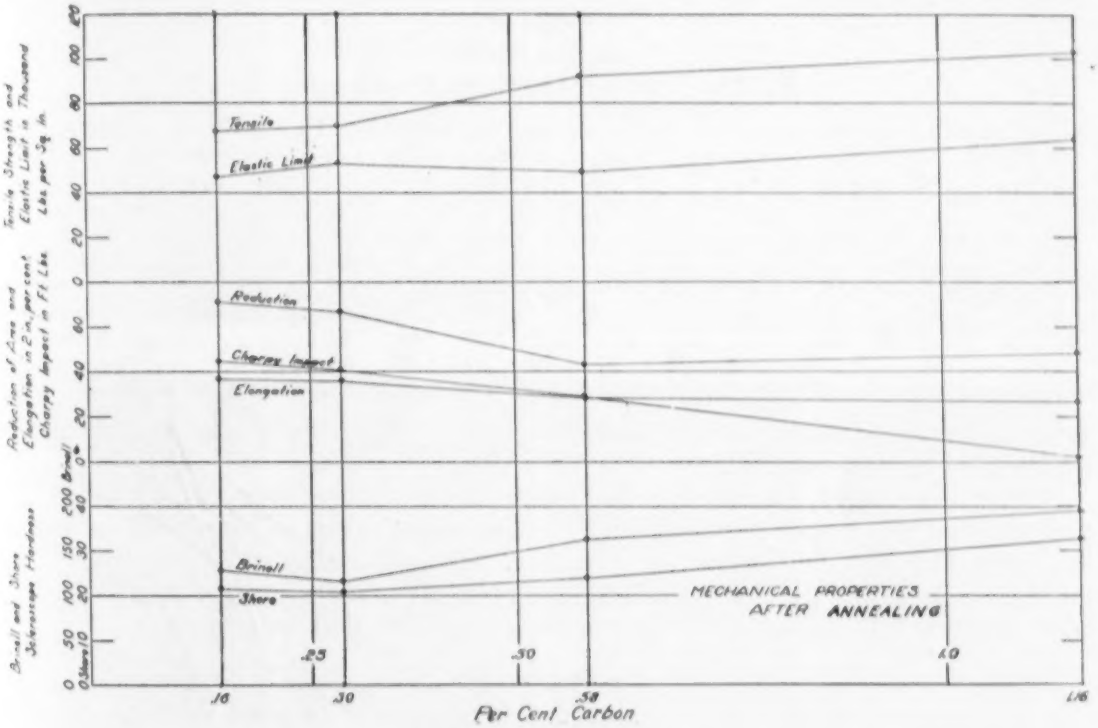
### *Heat Treatment*

The quenching temperature range throughout which, a refining of the texture was produced, was determined with the aid of the fracture test,

*Figures appearing in parentheses refer to bibliography at the conclusion of this paper.

hardness measurements and the microscope. For the fracture tests, a 1-inch round bar, notched at 1-inch intervals was heated through a long thermal gradient, varying from the cold to fusion. The resulting fractures varied from the granular type in the cooler portions, through the extremely fine-textured types of the refining range to the coarsened or crystalline types of the highly heated portions. The positions of the types of fracture along the bar were noted and the corresponding temperatures estimated. From the estimates, a series of notched specimens were heated to different temperatures within the refining range. The hardness and structure of these specimens were determined and the typical fracture of each, examined.

The influence of different quenching temperatures within the refining range upon the hardness, may be observed from the data recorded in Table




CARBON SERIES

Fig. 1. Mechanical Properties After Annealing at 1500° F. for 8 Hours.

II. Higher temperatures further increase the hardness. In the case of the 1.16 per cent carbon steel, the increasing hardness is carried into the region in which the determination of hardness by the Brinell method, becomes unreliable.

The increasing hardness, with increasing temperatures is undoubtedly caused by the solution of the iron-chromium-carbon compounds in the austenite prevailing at the high temperatures. The temperature at which an appreciable absorption and dispersion of the carbides occurs in the solid solution is marked by a sharp increase in hardness. The lower temperatures at which an increase in hardness appears in the higher carbon steels, is in keeping with the well-known effect of carbon in lowering the upper transformation or $Ac_3$ point upon heating and the effectiveness of the alloys present, in assisting in preventing the occurrence of the reverse transformation upon quenching. The influence of these alloys upon the critical points of the various steels

*A paper by the author presented at the Detroit convention entitled *Thermal Transformations of Some Chrome-Vanadium Steels.*

used in this investigation, will be published in a later issue of TRANSACTIONS.*

The effect of the increasing carbon content upon the hardness of different steels which have been quenched from identical temperatures, is illustrated in Fig. 2. A progressive increase in hardness with an increasing carbon content is shown.

The effect of various quenching temperatures upon the tensile properties of the heat-treated steels is recorded in Table III. An increase in strength and hardness with increasing carbon, is noticeable. The failure of the high-carbon steel to develop a high tensile strength corresponding to its projected place in the increasing strength movement, may have been caused by the low quenching temperatures and the comparatively high tempering temperature which were employed in its treatment. Obviously, higher quenching tempera-

**Table II**
**Carbon Series**
**Hardness After Quenching Treatments**

| No. | Chemical Composition | | | | Quenching Temperatures—Degrees F. | | | | | | | | | | Hardness |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | C | Mn | Cr | V | 1300 | 1350 | 1400 | 1450 | 1500 | 1550 | 1600 | 1650 | 1700 | 1750 | |
| 1 | .16 | .55 | 1.03 | .20 | .... | .... | .... | 259 | 255 | 273 | 273 | 393 | 399 | 380 | Brinell |
| | .... | .... | .... | .... | .... | .... | .... | 36 | 38 | 37 | 37 | 53 | 50 | 54 | Scleroscope |
| 2 | .30 | .68 | .93 | .18 | .... | .... | .... | .... | 444 | 460 | 475 | 477 | .... | .... | Brinell |
| | .... | .... | .... | .... | .... | .... | .... | .... | 59 | 63 | 65 | 67 | .... | .... | Scleroscope |
| 3 | .58 | .68 | .73 | .18 | .... | .... | .... | .... | 627 | 578 | 652 | .... | .... | .... | Brinell |
| | .... | .... | .... | .... | .... | .... | .... | .... | 73 | 70 | 82 | .... | .. | .... | Scleroscope |
| 4 | 1.16 | .55 | 1.06 | .20 | 217 | 217 | 223 | 652 | 782 | 782 | 782 | .... | .... | .... | Brinell |
| | .... | .... | .... | .... | 28 | 31 | 33 | 70 | 84 | 86 | 86 | .... | ..... | ..... | Scleroscope |

tures than those used, are necessary in order that this steel may occupy a position of greater strength.

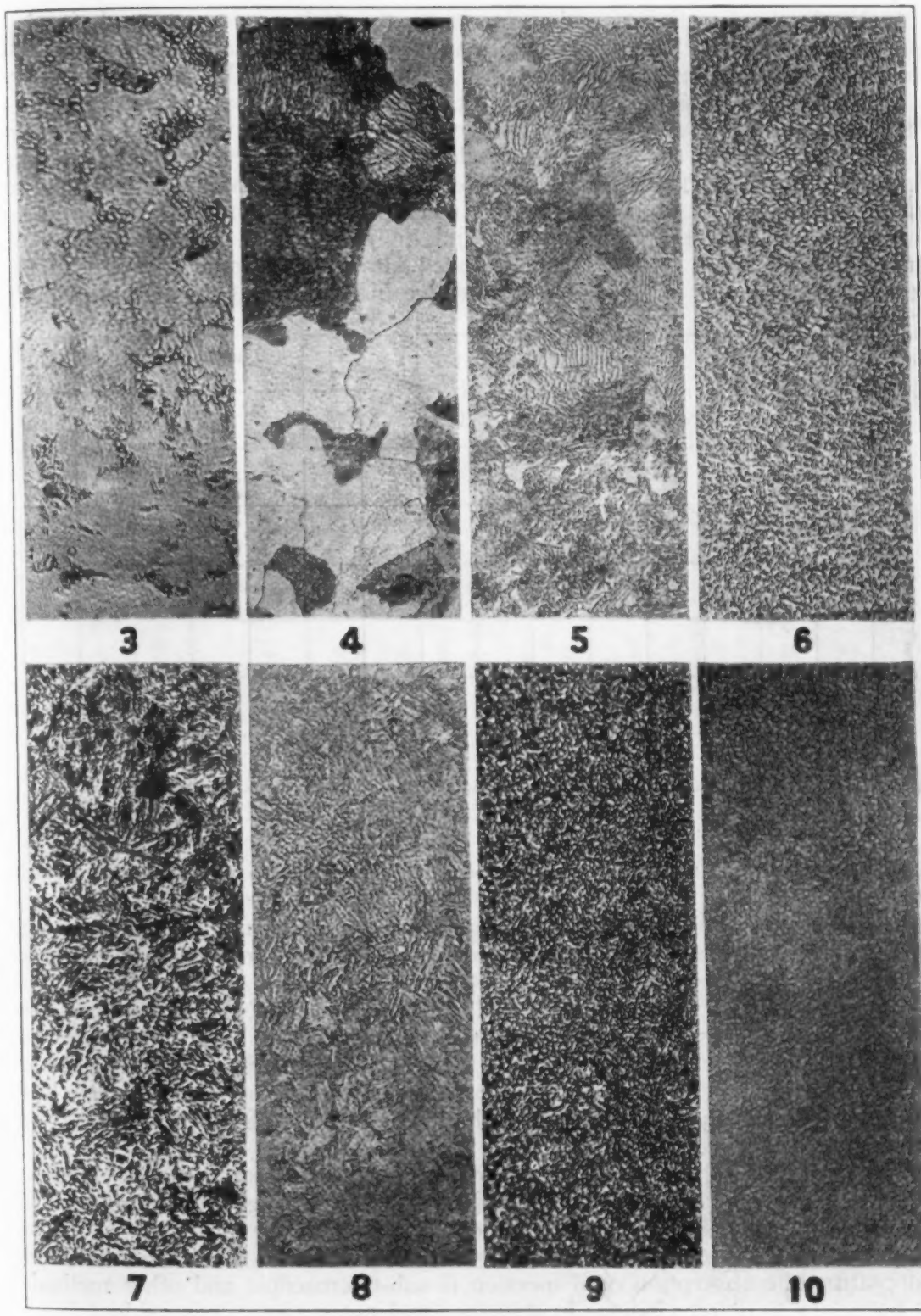
For each steel, increasing quenching temperatures are accompanied by greater strength and lowered ductility. The importance of the latter property in controlling the application of the steel to most industrial purposes is apparent. Consequently the quenching temperature which may be used is limited in part by its relation to the resulting ductility and toughness.

### *Microstructure*

The microstructures of the annealed steels are illustrated in Figs. 3 to 6. The structure in general, resembles that of the corresponding carbon steels. In the hypo-euctectoid steels, the normal constituents, pearlite and ferrite appear uniformly distributed throughout the mass. The high carbon steel shows the usual cementite precipitation.

A few important points of difference between the structure of the alloy steels and the corresponding carbon steels, may be mentioned. For example, McWilliam and Barnes (7), in describing the influence of .2 per cent vanadium upon the structure of different carbon steels, report the occurrence of varieties of pearlite, differing in color. This effect is in evidence in all of the pearlitic steels examined which contain the alloying elements. Differences in the resistance to etching, due to small variations in the alloy content of the individual pearlitic patches, undoubtedly are responsible for the color effects.

The alloys are capable, when present in sufficient quantity, of constricting the pearlitic areas thus making the steel appear to contain less carbon than the quantity actually present. Both vanadium and chromium exert this property. In the present series of carbon steels, chromium is probably most active. In Fig. 3, for example, the normal lamellar type of pearlite is replaced by the granular type. In this case the ratio of carbon to chromium is approximately




CARBON SERIES

Microstructure of Annealed (1.0% Cr.,—.18% V) Carbon Steels. Specimens Etched in 2% Alcoholic Nitric Acid. Magnification × 500. Fig. 3. Carbon .16%. Fig. 4. Carbon .30%. Fig. 5. Carbon .63%. Fig. 6. Carbon 1.16%

Microstructure of Quenched and Tempered (1.0% Cr., .18% V) Carbon Steels. Specimens Etched in 2% Alcoholic Nitric Acid. Magnification × 500. Fig. 7 Carbon .30%. Quenched from 1600°F. Fig. 8 Same as Fig. 7. Tempered at 1050°F. Fig. 9 Carbon 1.10%. Quenched from 1550°F. Fig. 10 Same as Fig. 9. Tempered at 1050°F.

6 to 1. As the quantity of carbon increases, the coalescence or granulation becomes less marked. The alloys are, however, capable of disengaging the pearlite from its characteristic lamellar form, into shorter lamellae of a less orderly arrangement. The size of the pearlite patches within a pearlitic area is therefore smaller than that prevailing in a corresponding carbon steel. The solution of the alloys in the cementite should increase the inherent strength of the cementite lamellae. The shorter lamellae of the pearlitic patches would tend to make the path of rupture through this constituent more intricate compared to the course taken through the longer and more orderly arranged lamellae of the ordinary carbon steels. The detached lamellae scattered throughout the ferrite grains would undoubtedly be effective in reinforcing the ferrite. These

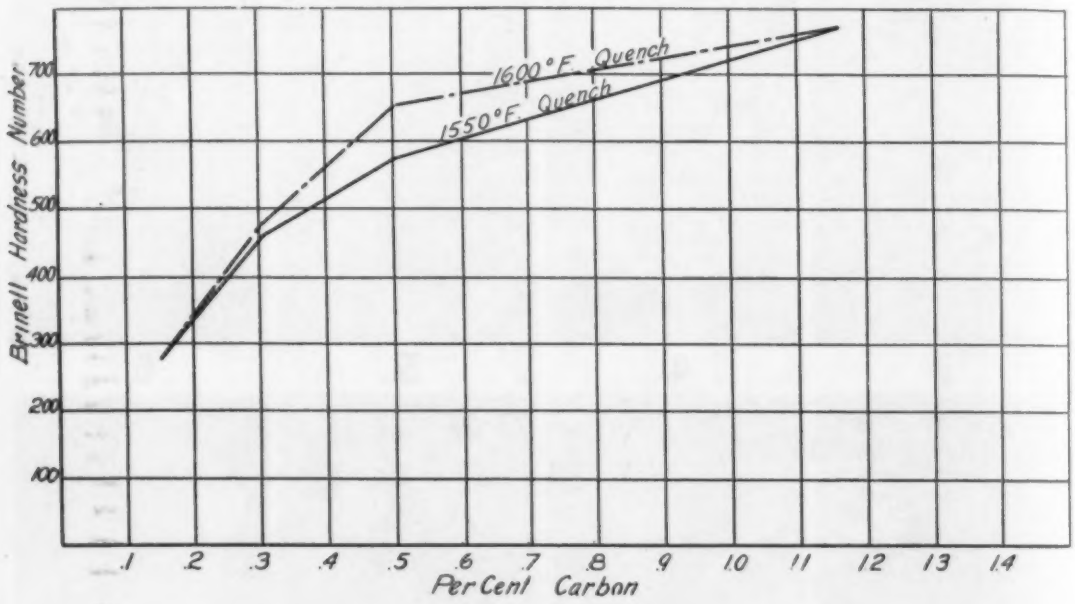



Fig. 2. Graph Showing the Increase in Hardness Resulting from an Increase in Carbon Content

various features of the structure, acting in unison in the metal under tension, would serve to improve the tensile properties of the alloy steels over those of the corresponding carbon steels.

Structures typical of the quenched and tempered steels are illustrated in Figs. 7 to 10. The structures of the quenched specimens follow the form of the corresponding carbon steels. The martensitic needles of the specimens quenched from successively higher temperatures adopt a longer sweep and coarsen progressively in agreement with the coarsening of the austenite from which they originate.

In the steels showing a pronounced precipitation of carbides, the solution of the carbides is not completed until comparatively high temperatures are reached. The partial absorption of the carbides may be observed in specimens quenched at temperatures rising to 1750 degrees Fahr. Above this temperature the absorption or dispersion is sub-microscopic and other methods are necessary to detect changes in structure and properties. It is evident, however, that the dispersion of the carbides of chromium and vanadium is not completed until comparatively high temperatures have been used. The structures of the tempered hypo-eutectoid steels retain the imprint of the structure of the quenched austenite. The hyper-eutectoid steel shows a pronounced precipitation of globular carbides.

**Table III**

**Carbon Series**

**Mechanical Properties of Rolled Bars**

Annealed 8 hours at 1500° F.

| No. | Chemical Composition C | Mn | Cr | V | Mechanical Properties Ultimate Strength Lbs. per sq. in. | Yield Point Lbs. per sq. in. | Elongation % in 2 inches | Reduction Area % | Brinell Numeral | Scleroscope | Charpy impact |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | .16 | .55 | 1.03 | .20 | 67,950 | 47,950 | 37.0 | 71.9 | 129 | 22 | 44.8 |
| 2 | .30 | .68 | .93 | .18 | 70,000 | 53,000* | 36.0 | 67.0 | 116 | 21 | 40.7 |
| 3 | .58 | .68 | .73 | .18 | 92,400 | 49,950* | 28.0 | 43.5 | 163 | 24 | 28.3 |
| 4 | 1.16 | .55 | 1.06 | .20 | 102,500 | 63,200 | 26.5 | 48.0 | 194 | 33 | 2.2 |

**Mechanical Properties After Heat Treatment.**

| No. | Chemical Composition C | Mn | Cr | V | Mechanical Properties Ultimate Strength Lbs. per sq. in. | Yield Point Lbs. per sq. in. | Elongation % in 2 inches | Reduction Area % | Brinell Numeral | Scleroscope | Treatment Water Quenched** |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1x | .16 | .55 | 1.03 | .20 | 114,650 | 103,100 | 22.5 | 68.0 | 231 | 42 | 1650° F |
| y | .... | ... | .... | ... | 114,300 | 100,000 | 23.5 | 67.5 | 252 | 44 | 1700° F |
| z | .... | ... | .... | ... | 122,200 | 112,450 | 20.5 | 67.0 | 255 | 45 | 1750° F |
| 2x | .30 | .68 | .93 | .18 | 145,800 | 107,000* | 17.0 | 58.7 | 277 | 49 | 1550° F |
| y | .... | ... | .... | ... | 152,850 | 115,000* | 17.0 | 55.5 | 297 | 51 | 1600° F |
| z | .... | ... | .... | ... | 158,800 | 117,000* | 17.5 | 54.5 | 306 | 51 | 1650° F |
| 3x | .58 | .68 | .73 | .18 | 162,000 | 125,000* | 16.0 | 49.5 | 293 | 49 | 1500° F |
| y | .... | ... | .... | ... | 173,100 | 135,100* | 15.0 | 45.5 | 332 | 52 | 1550° F |
| z | .... | ... | .... | ... | 180,800 | 140,000* | 13.5 | 37.5 | 351 | 54 | 1600° F |
| 4x | 1.16 | .55 | 1.06 | .20 | 103,050 | 59,750 | 22.0 | 45.0 | 212 | 39 | 1400° F |
| y | .... | ... | .... | ... | 114,250 | 83,200 | 20.5 | 39.0 | 221 | 43 | 1450° F |
| z | .... | ... | .... | ... | 133,000 | ..... | 17.0 | 31.0 | 262 | 45 | 1500° F |

** All quenched specimens, tempered at 1050° F.

*Proportional Limit.

## Vanadium Series

The early work of Arnold (8, 9) followed by the investigations of others, (10-12) established the value of vanadium as an alloying element. Subsequent developments have shown that .20 per cent or less of the element is sufficient to produce an improvement in ordinary carbon steel. The mechanical properties of carbon vanadium steels after various thermal treatments have been publishd by McWilliam and Barnes (7), Norris (12) and others.

Vanadium has further found a wide application in the manufacture of quaternary steels. Of these, the vanadium-chromium steels described in the previous section form an important group. The amount of vanadium in the

**Table IV**

**Vanadium Series**
**Hardness After Quenching Treatments**

| No. | Chemical Composition | | | | Quenching Temperatures—Degrees F. | | | | | | | | Hardness |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | C | Mn | Cr | V | 1400 | 1450 | 1500 | 1550 | 1600 | 1650 | 1700 | 1750 | |
| 1 | .40 | .53 | 1.05 | .025 | 196 | 396 | 415 | 438 | 495 | 512 | .... | .... | Brinell |
| | ... | ... | .... | .... | 27 | 51 | 54 | 56 | 67 | 62 | .... | .... | Scleroscope |
| 2 | .37 | .52 | 1.05 | .07 | .... | 578 | 578 | 566 | 600 | 600 | 616 | 578 | Brinell |
| | ... | ... | .... | .... | .... | 56 | 57 | 60 | 66 | 66 | 69 | 67 | Scleroscope |
| 3 | .35 | .37 | 1.02 | .14 | .... | .... | 512 | 495 | 555 | 546 | 555 | 512 | Brinell |
| | ... | ... | .... | .... | .... | .... | 64 | 66 | 68 | 67 | 68 | 65 | Scleroscope |
| 4 | .30 | .68 | .93 | .18 | .... | .... | 444 | 460 | 475 | 477 | .... | .... | Brinell |
| | ... | ... | .... | .... | .... | .... | 59 | 63 | 65 | 67 | .... | .... | Scleroscope |
| 5 | .37 | .55 | 1.07 | .31 | 174 | 457 | 460 | 512 | 532 | 569 | .... | .... | Brinell |
| | ... | ... | .... | .... | 24 | 59 | 60 | 62 | 64 | 65 | .... | .... | Scleroscope |
| 6 | .27 | .34 | .124 | .65 | .... | .... | 202 | 340 | 402 | 430 | 452 | 460 | Brinell |
| | ... | ... | .... | .... | .... | .... | 53 | 59 | 56 | 59 | 65 | 65 | Sclerosco p |

forging steels seldom exceeds .20 per cent. In the steels described in this section, the vanadium addition was varied on either side of this amount. The composition of the vanadium series of steels used in the following tests, is listed in Table I. The vanadium content desired, had been quite closely approached although the close control of the quantity of the remaining elements present, encountered practical difficulties. In view of the very small quantities of vanadium added, differences in the chromium, manganese and carbon contents must be considered in interpreting the data obtained. With this precaution in mind, the limits within which vanadium may be said to improve the steel under the conditions of heat-treatment applied, can be derived from the test data.

### *Annealed Steels*

The tensile test data are listed in Table V. The annealed specimens show comparatively small differences in tensile properties. Fig. 11 graphically shows the narrow range through which these properties move. In comparing the properties of the steels in the order of increasing vanadium, an improvement in the toughness as measured by the yield point, per cent elongation, and reduction, may be followed. This improvement appears to be greater than the decrease in carbon would warrant, thus suggesting its connection with the increasing vanadium content[6].

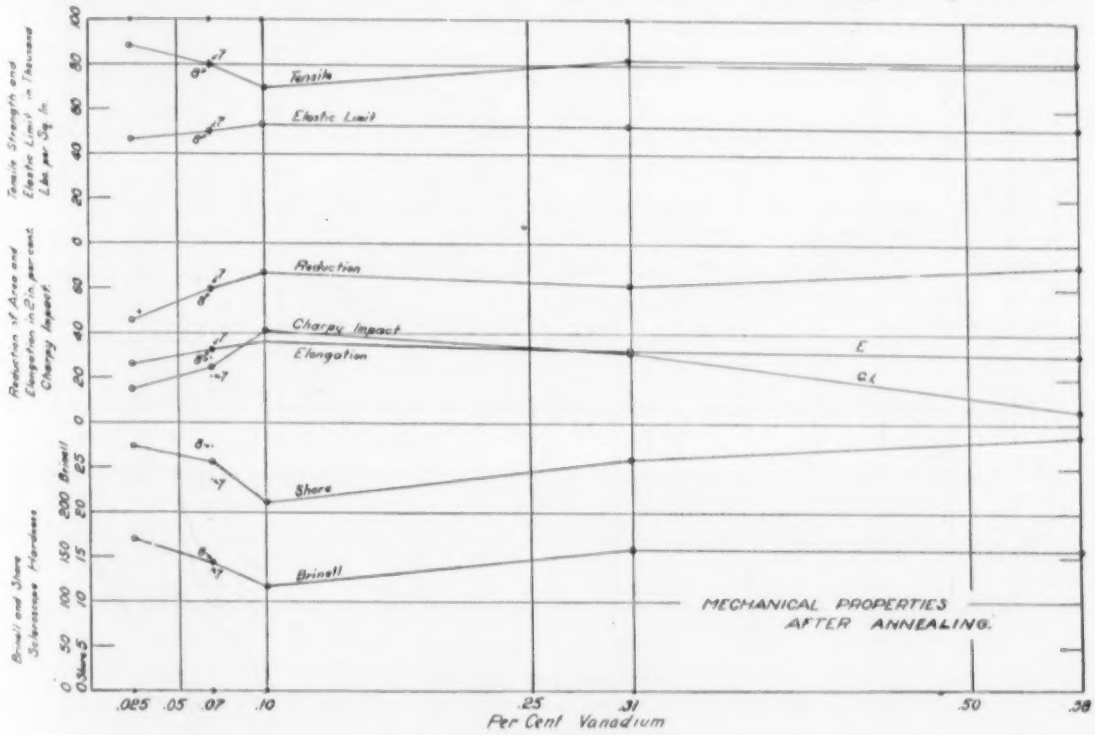
### *Heat Treatment*

The quenching temperature ranges within which a macroscopic refining

6. The relative value of vanadium and chromium in a steel containing .40 per cent carbon may be compared from the test data on steel No. 1 of Table V and Table VII.

of the texture occurred, were obtained by the fracture method. This method roughly established the quenching range between 1450 and 1750 degrees Fahr. for the entire series. An examination of the microstructure and the determination of the hardness of the quenched specimens further restricted this range for each individual steel.

An inspection of the hardness data obtained from tests on the quenched specimens, shows, as would be expected, that hardening begins at 1450 degrees Fahr. and increases gradually with higher quenching temperatures. The hardness reaches a maximum at 1700 degrees Fahr. thus suggesting a maxi-




**VANADIUM SERIES**

Fig. 11. Mechanical Properties After Annealing at 1500°F. for 8 Hours.

mum diffusion of the carbides at this temperature. The increase in hardness, accompanying increasing quenching temperatures, is graphically shown in Fig. 12. The addition of a small quantity of vanadium to the chrome-carbon steel, slightly increases the hardness. Changes in hardness bear a more direct connection with the carbon content of the steel, thus indicating that small differences in carbon are capable of obscuring the hardening effect of small variations in vanadium.

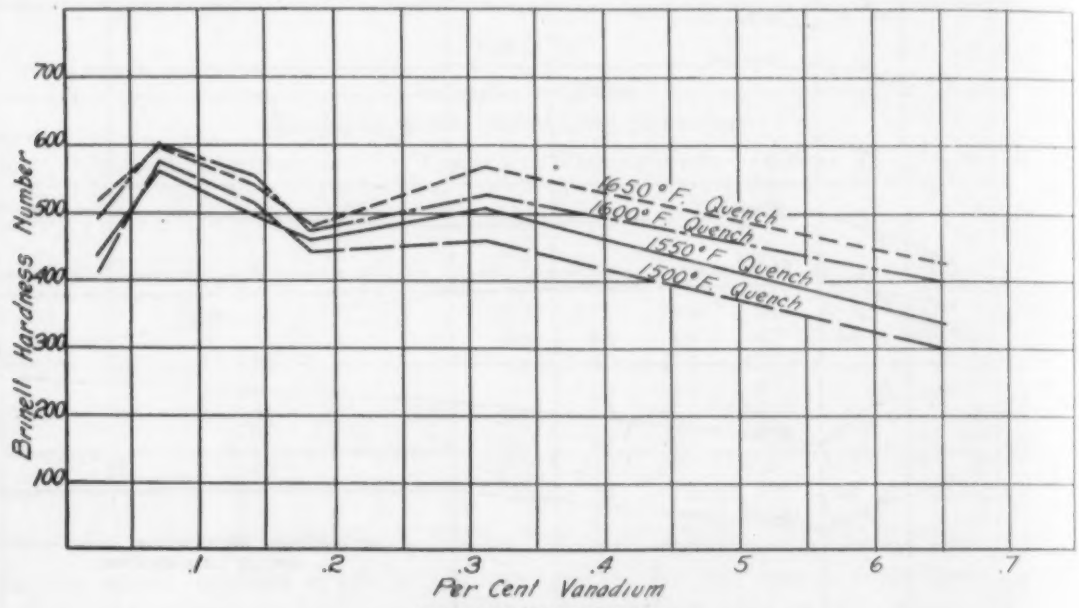
The effect of different quenching temperatures upon the tensile and hardness properties of the tempered steels is recorded in Table V. The tensile and hardness properties increase, in general, with an increase in the quantity of vanadium added. The ability of the heat treated steels to retain a high degree of ductility is expressed in the high values for the reduction of area. The steel has the ability to deform severely in a localized section thus giving rise to a high reduction of area although it is attended by a decreased elongation. This property cannot be attributed to vanadium alone since chromium steels, containing up to 2 per cent chromium, produce similar results. The quantity of chromium necessary to produce this effect is greater however, thus indicating the more intensive activity of vanadium in this respect.

A gradual increase in tensile strength and hardness may be noted for

individual groups of identical composition which have been quenched in the 1550 to 1650 degrees Fahr. range. There is apparently no advantage in quenching from temperatures higher than 1650 degrees Fahr. For most practical purposes, 1650 degrees Fahr., need not be exceeded.

*Microstructure*

The effect of vanadium upon the constitution and structure of different steels, has been described by several authors. In each case, the condition of the steel with reference to its composition and heat treatment, must be considered to successfully interpret the significance of small changes in structure. Frequently large differences in composition obscure the positions of



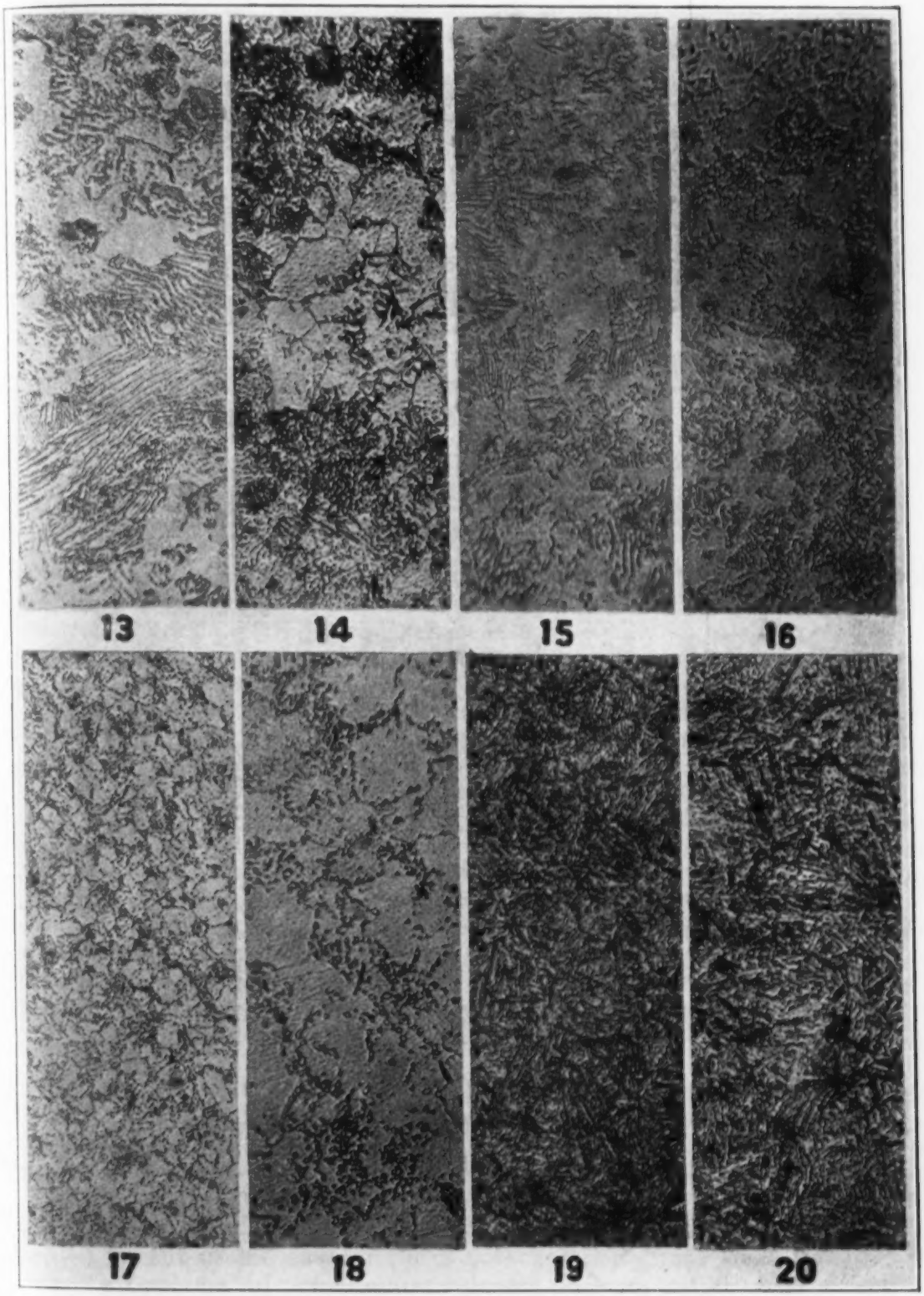

**VANADIUM SERIES**

**Fig. 12. Graph Showing the Changes in Hardness (Brinell) with the Addition of Vanadium.**

sharp internal changes. Since the vanadium content of this series of steels varies through a comparatively narrow range, and the ratio of carbon to chromium is nearly constant the effect of vanadium upon the microstructure can be closely followed. Figs. 13 to 18 illustrate the structures typical of the annealed specimens. In general, the relation between the composition and the structure follows the discussion given under the description of the structure of the carbon series of steels.

The smoothly developed grains of pearlite characteristic of a carbon steel are succeeded by smaller patches of a less regular form. The ferrite grains are smaller and frequently cut up by scattered strands of cementite or small aggregates of pearlite. Like chromium, vanadium is active in disturbing the orderly grouping of the pearlitic lamellae. Fig. 13 illustrates the irregular arrangement which the pearlitic lamellae adopt. On account of the small amount of vanadium present in the example cited, the effect is largely caused by chromium. However, as mentioned above, both elements act similarly.

As the quantity of vanadium increases, the pearlitic areas are considerably reduced and their individual lamellae, correspondingly shortened. Figs. 15 and 16 illustrate these conditions. With a further addition of vanadium the cementite lamellae are reduced to aggregates of globules and the pearlitic areas adopt the granular form. Figs. 17 and 18 show this particular form of structure. Small ferritic grains are bordered by colonies of the granular




**VANADIUM SERIES**

Microstructure of Annealed (.30—.40% C.,—1.0% Cr.) Vanadium Steels. Specimens Etched in 2% Alcoholic Nitric Acid. Magnification × 500. Fig. 13 Vanadium .025%. Fig. 14 Vanadium .07%. Fig. 15 Vanadium .14%. Fig. 16 Vanadium .31%. Fig. 17 Vanadium .65%. Annealed × 100. Fig. 18 Same as Fig. 17 × 500. Fig. 19 Same as Fig. 17. Quenched from 1650°F. × 500. Fig. 20 Same as Fig. 13. Quenched from 1650°F. × 500.

## Table V

### Vanadium Series
### Mechanical Properties of Rolled Bars

Annealed 8 Hours at 1500° F.

| No. | C | Mn | Cr | V | Mechanical Properties: Ultimate Strength Lbs. per sq. in. | Yield Point Lbs. per sq. in. | Elongation % In 2 inches | Reduction Area % | Brinell Numeral | Scleroscope | Charp Impact |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | .40 | .53 | 1.05 | .02 | 88,250 | 46,250 | 26.0 | 45.8 | 170 | 27 | 14.6 |
| 2 | .37 | .52 | 1.05 | .07 | 80,300 | 50,950 | 33.0 | 59.9 | 143 | 24 | 20.1 |
| 3 | .35 | .37 | 1.02 | .14 | 78,750 | 49,000 | 32.0 | 59.3 | 144 | 27 | 29.8 |
| 4 | .30 | .68 | .93 | .18 | 70,000 | 53,000* | 36.0 | 67.0 | 116 | 21 | 40.7 |
| 5 | .37 | .55 | 1.07 | .31 | 82,750 | 52,300 | 31.5 | 61.0 | 159 | 26 | 31.3 |
| 6 | .27 | .34 | 1.24 | .65 | 81,500 | 51,300 | 30.0 | 70.3 | 158 | 29 | 5.7 |

### Mechanical Properties after Heat Treatment

| | | | | | Quenched and Tempered | | | | | | Treatment** Quenched |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1x | .40 | .53 | 1.05 | .02 | 119,750 | 94,500 | 22.0 | 66.5 | 259 | 49 | 1550° F |
| y | .... | ... | .... | ... | 113,400 | 93,500 | 21.5 | 65.5 | 255 | 49 | 1600° F |
| z | .... | ... | .... | ... | 124,750 | 106,750 | 20.0 | 63.5 | 255 | 49 | 1650° F |
| 2x | .37 | .52 | 1.05 | .07 | 132,400 | 121,100 | 20.0 | 59.0 | 282 | 48 | 1600° F |
| y | .... | ... | .... | ... | 132,900 | 119,400 | 20.5 | 59.5 | 286 | 49 | 1650° F |
| z | .... | ... | .... | ... | 134,850 | 121,400 | 20.0 | 58.0 | 289 | 49 | 1700° F |
| 3x | .35 | .37 | 1.02 | .14 | 144,800 | 135,500 | 16.5 | 57.8 | 302 | 50 | 1600° F |
| y | .... | ... | .... | ... | 152,350 | 145,001 | 15.5 | 55.5 | 321 | 50 | 1650° F |
| z | .... | ... | .... | .... | 158,800 | 147,500 | 15.0 | 52.7 | 338 | 46 | 1700° F |
| 4x | .30 | .68 | .93 | .18 | 145,800 | 107,000* | 17.0 | 58.7 | 277 | 49 | 1550° F |
| y | .... | ... | .... | ... | 152,850 | 115,000* | 17.0 | 55.5 | 297 | 51 | 1600° F |
| z | .... | ... | .... | ... | 158,800 | 117,000* | 17.5 | 54.5 | 306 | 51 | 1650° F |
| 5x | .37 | .55 | 1.07 | .31 | 119,500 | 110,450 | 21.5 | 64.0 | 263 | 48 | 1550° F |
| y | .... | ... | .... | ... | 130,700 | 122,750 | 19.5 | 67.0 | 269 | 50 | 1600° F |
| z | .... | ... | .... | ... | 132,650 | 128,300 | 19.5 | 58.5 | 286 | 50 | 1650° F |
| 6x | .27 | .34 | 1.24 | .65 | 165,000 | 147,900 | 15.0 | 55.0 | 332 | 49 | 1650° F |
| y | .... | ... | .... | ... | 169,200 | 159,200 | 14.0 | 51.0 | 335 | 48 | 1700° F |
| z | .... | ... | .... | ... | 160,200 | 144,000 | 11.0 | 55.4 | 344 | 50 | 1750° F |

* Proportional limit

** All specimens tempered at 1050° F. after quenching.

carbides. The ferritic grains are further cut up by thin segmented strands or isolated globules of the complex carbides. The structure consists of a ferritic matrix cut up by a net work of the carbidic globules. The slow cooling of the austenitic solution permits the excretion and concentration of the carbidic globules at the ferritic grain boundaries.

The relation between the quantity and distribution of the two principal components of the structure is reflected in the tensile properties. Vanadium and chromium are but slightly soluble in ferrite when cementite is present. The solution of the two alloys would be expected to increase the tensile strength. Of the two elements, vanadium is more powerful in concentrating the cementite into the globular form. The concentration of the cementite into globules, liberates large areas of the ductile ferritic component. The unusual ductility must result.

Figs. 19 and 20 illustrate the structure of the quenched steels. The structures resemble those of the previous series and the same general remarks apply to both. The degree of coarseness of the martensite appears to be lessened in favor of those steels containing a greater amount of the alloy. The tempered structures largely retain the imprint or configuration of their martensitic predecessors.

## Chromium Series

The value of chromium as an alloying element has long been recognized. The early investigations of Hadfield (13), Guillet (14, 15) and others (11, 16, 17), indicated the effect of the element upon the physical properties of steels. Chromium, alone, or in combination with nickel, tungsten, molybdenum and vanadium forms a number of highly useful steels. The most familiar types of chromium steels contain 1 per cent or less of the alloy. Steels containing more than 1 per cent are regarded as special purpose alloys. Excluding tool steels, few alloy steels are made with a chromium content in the 2 to 12 per cent range. Above 12 per cent, the corrosion resisting *stainless* steels come into use. The mechanical properties of the high chromium steels have been described by several authors (18, 20). The prompt response of the high chromium steels to changes in composition and heat treatment demands that these two factors be considered in the interpretation of test data.

In the steels used in the following tests the chromium content was chosen to include steels of the *stainless* or high chromium type. In addition the vanadium content of .18 per cent was desired. Some difficulty was experienced in maintaining a fixed vanadium content throughout the series. The compositions recorded in Part C of Table I, were finally accepted.

### *Annealed Steels*

The influence of chromium upon the mechanical properties of the annealed steels is recorded in Table VII. No marked change is noticeable until 7.7 per cent chromium is reached. At this point a maximum tensile strength is attained which is maintained with the addition of chromium up to 14.4 per cent. The influence of the small amount of vanadium may be disregarded except in the case of the 2 per cent chromium steel, in which a larger proportion of vanadium evidently interrupts the true effect of chomium.

### *Heat Treatment*

Specimens representing each of the steels were quenched from different temperatures within their refining range as determined by the fracture test.

**Table VI**

**Chromium Series**

**Hardness After Quenching Treatments**

| No. | Chemical Composition | | | | Quenching Temperatures—Degrees F. | | | | | | | | | | Hardness |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | C | Mn | Cr | V | 1400 | 1450 | 1500 | 1550 | 1600 | 1650 | 1700 | 1750 | 1800 | 1850 | |
| 1 | .38 | .39 | .04 | .19 | 174 | 228 | 232 | 241 | 241 | 251 | .... | .... | .... | .... | Brinell |
| | ... | ... | ..... | ... | 26 | 32 | 35 | 37 | 34 | 35 | .... | .... | .... | .... | Scleroscope |
| 2 | .29 | .53 | .51 | .28 | 191 | 210 | 225 | 227 | 262 | 277 | 386 | 477 | .... | .... | Brinell |
| | ... | ... | ... | ... | 31 | 33 | 32 | 34 | 37 | 39 | 48 | 57 | .... | .... | Scleroscope |
| 3 | .30 | .68 | .93 | .18 | .... | .... | 444 | 460 | 475 | 477 | .... | .... | .... | .... | Brinell |
| | ... | ... | ... | ... | .... | .... | 59 | 63 | 65 | 67 | .... | .... | .... | .... | Scleroscope |
| 4 | .31 | .48 | 2.01 | .34 | .... | 336 | 387 | 393 | 460 | 503 | 502 | 495 | .... | .... | Brinell |
| | ... | ... | ... | ... | .... | 45 | 44 | 48 | 65 | 62 | 65 | 60 | .... | .... | Scleroscope |
| 5 | .33 | .37 | 7.70 | .18 | .... | .... | .... | 444 | 512 | 512 | 532 | 555 | .... | .... | Brinell |
| | ... | ... | ... | ... | .... | .... | .... | 60 | 64 | 62 | 62 | 66 | 65 | .... | Scleroscope |
| 6 | .42 | .35 | 14.40 | .18 | .... | .... | .... | .... | 452 | 477 | 503 | 569 | 543 | 612 | Brinell |
| | ... | ... | ..... | ... | .... | .... | .... | .... | 63 | 64 | 65 | 68 | 67 | 71 | Scleroscope |

The fractures, hardness and microstructure were noted. A refinement in the texture of the fractured surfaces was included in a range varying from 1550 to 1850 degrees Fahr. Fine grained fractures of the porcelainic type were obtained in quenching the high chromium steels from temperatures as high as 1850 degrees Fahr. Temperatures above this were not investigated.

Table VI records some of the hardness data. A distinct increase in hardness occurs in specimens quenched from 1600 degrees Fahr. This temperature marks the position of a rapid dissociation of the carbides of chromium. The dissociation continues with increasing temperatures, the hardness increasing as the chromium compounds are further diffused. Quenching temperatures as high as 1850 degrees Fahr. are accompanied by greater hardness. Quenching a *stainless* steel in oil, French (20) obtained a maximum hardness at 1950 degrees Fahr., which was maintained to 2250 degrees Fahr., the final quenching temperature investigated. It is evident that the dispersion of the chromium carbides in the solution is not complete until these high temperatures have been attained.

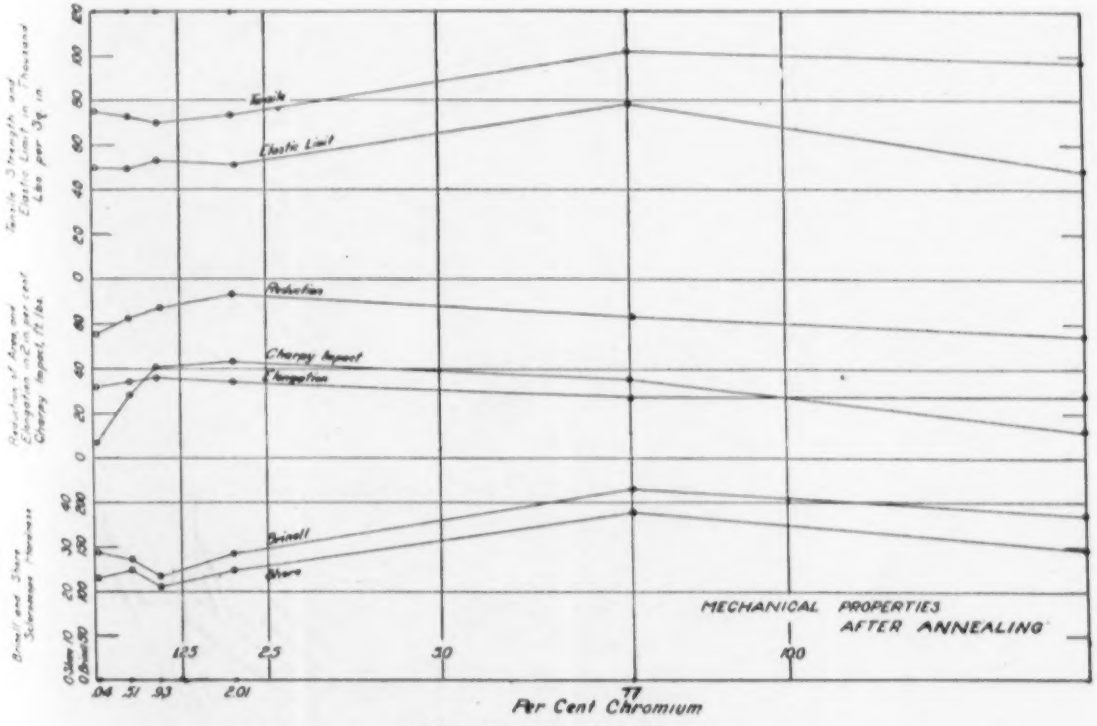
Fig. 21 illustrates graphically the effect of chromium upon the hardness of the quenched steels. A rapid increase is obtained by adding 1 per cent chromium. An increase in chromium up to 7.7 per cent, further increases the hardness. Chromium in excess of this amount does not appear to add to the hardness of the metal. There is obviously a definite relation between the quantity of chromium and carbon, that determines the position of a maximum hardness. In addition the rate of cooling exerts a profound effect.

The effect of different quenching temperatures upon the tensile and hardness properties of the tempered steels is shown in Table VII. A graduai increase in tensile strength accompanied by a corresponding loss in ductility is shown. As might be expected, a higher quenching temperature for different members of identical composition is accompanied by a greater tensile strength, but decreased ductility. The very high quenching temperatures that are necessary to dissolve the carbides of steels containing large percentages of chromium, produce sharp changes in the mechanical properties. Caution must be used in applying steels so treated to service. For service as *stainless* steels, Hatfield (18) recommends a quenching in water from 1832 degrees Fahr. The *stainless* type of steel is inherently brittle due to its large chrom-

ium content. Quenching from the high temperatures that are necessary to develop the stainless qualities, render the steel, unfit for many other purposes. Where the corrosion factor is unimportant lower temperatures are preferrable.

*Microstructure*

Structures typical of the annealed steels are illustrated in Figs. 23 to 26. The structures of low chromium steels, annealed at 1500 degrees Fahr. are pearlitic, and in general, similar to those prevailing in an alloy-free steel of an equal carbon content. The change in the color of the pearlite and a




CHROMIUM SERIES

Fig. 21. Mechanical Properties After Annealing at 1500°F. for 8 Hours

gradual decrease in the volume of this constituent with an increase in chromium, is noticeable. As the quantity of chromium reaches 2 per cent, the pearlitic areas which would be expected to occur in an alloy-free steel, are constricted into irregular chords and globular particles. The structure, as shown in Fig. 24, consists of a ferritic matrix, spotted with patches of globular particles and thin segmented veins of the iron-chromium carbides.

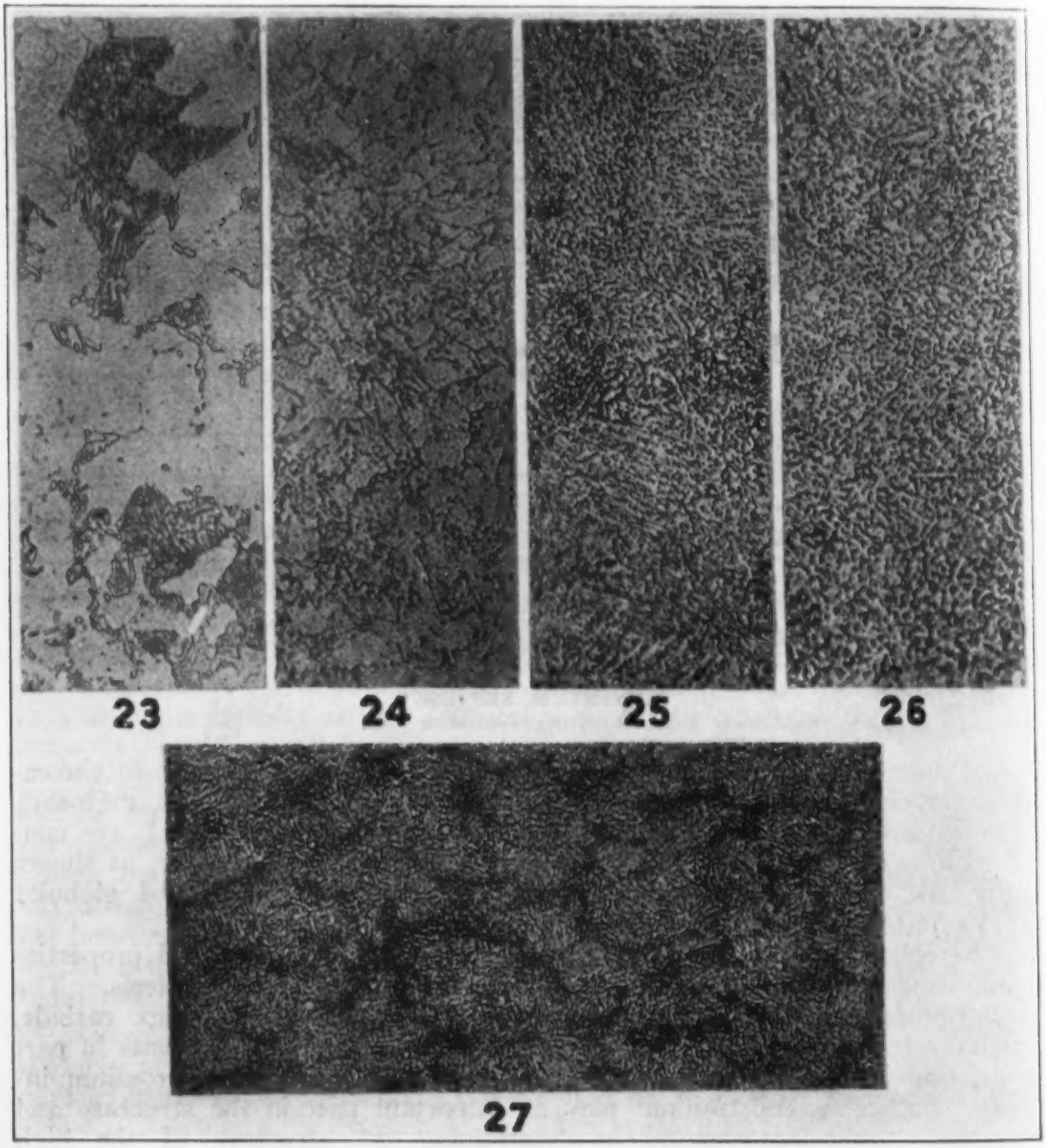
The relation drawn between the structure and the mechanical properties of the vanadium steels applies equally to the low chromium steels. The concentration of the cementitic component into the hard, complex carbide, particles, releases large areas of the ferritic component. This accounts in part for the improved ductility of these steels. As the quantity of chromium increases, changes in constitution[7] play an important part in the structure and properties. Important factors in determining the structure of the high chromium steels are; (a) the composition, (b) the temperature of heating, (c) the rate of cooling.

The microstructure of the high chromium steels is almost entirely martensitic, Figs. 25 and 26, representing steels which contain 7.7 and 14.4

7. The recent inestigations of Murakami (21), Edwards (22), and Monypenny (23), should be consulted for information relative to the structure and constitution of chromium steels.

per cent chromium respectively, show this structure. The needle-like form of martensite is not sharply developed. In its stead, the 'V' shaped valleys filled with minute carbide globules, outline the characteristic martensitic configuration. In Fig. 26, this structural pattern is completely lost in the heavy precipitation of carbide globules which thoroughly spatter the matrix. The increase in the quantity of chromium is thus reflected in the structure by an increase in the size or number of carbide particles. Apparently a portion at least, of the added chromium, enters into solution in the carbide globules.

The probable composition of the iron-chromium carbides has been sug-

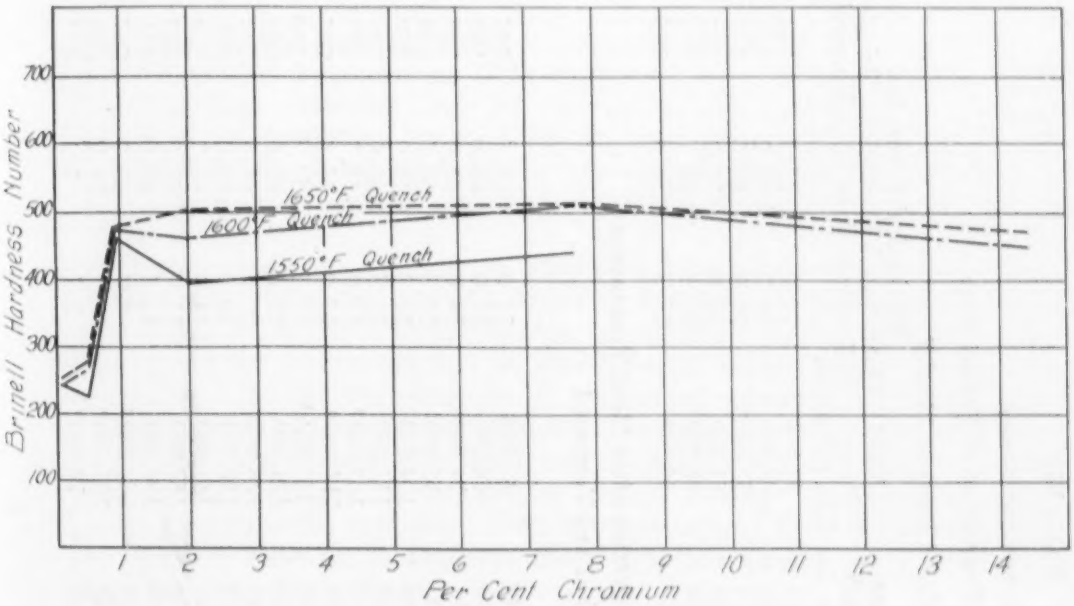



**CHROMIUM SERIES**

Microstructure of Annealed (.30—.40%C.,—.18% V) Chromium Steels. Fig. 23 Chromium .51%. Fig. 24 Chromium 2.01%. Specimens Etched in 2% Alcoholic Nitric Acid. Magnification × 500. Fig. 25 Chromium 7.70%. Fig. 26 Chromium 14.4%. Specimens Etched in a 50% Solution of 1 Part Nitric Acid, 3 Parts Hydrochloric Acid in Water. Magnification × 500. Fig. 27 Chromium 7.70% Same as Fig. 25. Showing Troostite Net-Work × 100.

gested by Murakami as a result of his magnetic analyses and etching tests. Attempts to identify the different carbides, by etching reagents have not been entirely successful. From the results of the etching tests, it is evident that the composition of the carbide globules varies with the initial temperature of heating, rate of cooling and alloy content of the steel under investigation. It is therefore difficult to predict the composition of the carbides and matrix without defining the conditions of heat-treatment.

It is conceivable that the composition of the carbides may vary from that of cementite to that of a carbide of chromium. Between these two carbides,




CHROMIUM SERIES

Fig. 22. Graph Showing the Changes in Hardness (Brinell) with Increasing Chromium.

a continuous series of double carbides may form in which the ratio of iron carbide to chromium carbide becomes smaller as the chromium content increases. Chromium would therefore replace a portion of the iron. Along this line of reasoning, it would be expected that the iron carbide and chromium carbide form a continuous solid solution which is not interrupted by definite points marking the formation of distinct double carbides.

Fig. 27 illustrates the appearance of a dark-etching network in the martensitic matrix of the 7.7 per cent chromium steel. The net work consists of very fine carbidic globules embedded in the darkened meshes. Since the addition of chromium to the steel retards the transformations on cooling and produces a structural condition similar to that obtained by an acceleration of the cooling rate, it is evident that the alloy content of the steel was such as to induce the partial transformation of the martensite into its decomposition products, in a manner similar to the formation of troostite in quenched or rapidly cooled carbon steel. The darkened meshes indicate that the abrupt transformation of austenite into troostite had occurred and been accompanied in the matrix by the less rapid transformation of austenite into martensite. The continuity of the darkened net-work marks the path of the austenitic decomposition along the boundaries of the former austenitic grains.

The structures of the quenched chromium steels are of particular interest in revealing the progress of the solution of excess carbides in the martensitic

## Table VII

### Chromium Series

### Mechanical Properties of Rolled Bars

Annealed 8 hours at 1500° F

| No. | Chemical Composition C | Mn | Cr | V | Mechanical Properties. Ultimate Strength Lbs. per sq. in. | Yield Point Lbs. per sq. in. | Elongation % in 2 inches | Reduction Area % | Brinell Numeral | Scleroscope | Charpy impact |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | .38 | .39 | .04 | .19 | 75,150 | 50,000 | 32.0 | 55.7 | 143 | 23 | 6.6 |
| 2 | .29 | .53 | .51 | .28 | 72,800 | 49,500 | 34.0 | 62.2 | 136 | 25 | 27.6 |
| 3 | .30 | .68 | .93 | .18 | 70,000 | 53,000* | 36.0 | 67.0 | 116 | 21 | 40.7 |
| 4 | .31 | .48 | 2.01 | .34 | 73,750 | 51,400 | 34.0 | 73.2 | 143 | 25 | 43.1 |
| 5 | .33 | .37 | 7.70 | .18 | 102,500 | 78,750 | 27.5 | 63.7 | 216 | 38 | 36.0 |
| 6 | .42 | .35 | 14.40 | .18 | 96,750 | 48,100 | 27.5 | 54.8 | 185 | 29 | 11.2 |

### Mechanical Properties after Heat Treatment

| No. | | | | | Quenched and Tempered | | | | | | Treatment Water Quenched** |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1x | .38 | .39 | .04 | .19 | 88,850 | 62,850 | 32.0 | 64.5 | 185 | 30 | 1500° F |
| y | .... | ... | .... | ... | 89,300 | 64,000 | 32.0 | 66.0 | 186 | 32 | 1550° F |
| z | .... | ... | .... | ... | 104,050 | 74,500 | 24.0 | 62.0 | 209 | 37 | 1600° F |
| 2x | .29 | .53 | .51 | .28 | 113,800 | 95,900 | 23.5 | 62.5 | 239 | 47 | 1650° F |
| y | .... | ... | .... | ... | 123,000 | 104,850 | 22.5 | 58.0 | 269 | 47 | 1700° F |
| z | .... | ... | .... | ... | 130,100 | 115,250 | 21.5 | 63.0 | 286 | 52 | 1750° F |
| 3x | .30 | .68 | .93 | .18 | 145,800 | 107,000* | 17.0 | 58.7 | 277 | 49 | 1550° F |
| y | .... | ... | .... | ... | 152,850 | 115,000* | 17.0 | 55.5 | 297 | 51 | 1600° F |
| z | .... | ... | .... | ... | 158,800 | 117,000* | 17.5 | 54.5 | 306 | 51 | 1650' F |
| 4x | .31 | .48 | 2.01 | .34 | 131,850 | 121,600 | 21.0 | 65.0 | 286 | 51 | 1600° F |
| y | .... | ... | .... | ... | 134,250 | 126,000 | 20.0 | 64.5 | 293 | 52 | 1650° F |
| z | .... | ... | .... | ... | 149,050 | 138,150 | 20.5 | 63.0 | 321 | 55 | 1700° F |
| 5x | .33 | .37 | 7.70 | .18 | 189,650 | 155,000 | 13.0 | 46.7 | 368 | 58 | 1650° F |
| y | .... | ... | .... | ... | 213,100 | 187,000 | 13.0 | 42.8 | 423 | 62 | 1700° F |
| z | .... | ... | .... | ... | 215,000 | 194,900 | 12.5 | 40.0 | 441 | 65 | 1750° F |
| 6x | .42 | .35 | 14.40 | .18 | 202,000 | 162,600* | 8.0 | 23.2 | 387 | 41 | 1650° F |
| y | .... | ... | .... | ... | 195,000 | 183,600* | 7.0 | 18.7 | 364 | 48 | 1750° F |
| z | .... | ... | .... | ... | 258,000 | 78,400* | 2.5 | 1.3 | 477 | 67 | 1850° F |

* Proportional Limit.

** All quenched specimens tempered at 1050° F

matrix. With small amounts of chromium, the structures follow the usual form, becoming martensitic as the quenching temperatures exceed 1500 degrees Fahr. Higher quenching temperatures do not coarsen the martensite to the same degree as that occurring in a corresponding carbon steel. This condition is undoubtedly associated with the influence of chromium. The gradual increase in hardness which these steels show when 1600 degrees Fahr. is exceeded, connects this change with the absorption of the complex carbides and the subsequent diffusion of the chromium and vanadium addition.

In the higher chromium steels, the hardness increases progressively as the temperature exceeds 1600 degrees Fahr. In the steel containing 14.4 per cent of chromium, the carbide particles become smaller as the temperature is increased and finally disappear at 1750 degrees Fahr. The absorption of the free iron-chromium carbides may be microscopically followed in specimens quenched from temperatures up to 1750 degrees Fahr. Above this temperature the distribution of the carbides is sub-microscopic as evidenced by the increasing hardness of steels quenched from temperatures exceeding 1750 degrees Fahr.

Tempering produces changes in structure similar to those occurring in carbon steels. The coarsened texture which is developed by quenching the low-chromium steels from high temperatures, is retained in the tempered matrix and recorded in the microstructure by the broader sweep of the former martensitic needles. As the temperature of tempering increases, a decomposition of the martensitic matrix occurs which is revealed in the structure by the roughening and blunting of the martensitic blades. At still higher temperatures, these markings are succeeded by wedge shaped or irregular, angular patches of an emulsified texture. The temperature of this decomposition appears to increase with an increase in the chromium content or a change to a higher quenching temperature.

In the steels containing 7.7 and 14.4 per cent chromium, which have been quenched from temperatures sufficiently high to absorb the carbide globules, tempering is accompanied by a gradual precipitation of carbides.

The net work of incipient troostite which forms upon quenching from lower temperatures, is preserved over a wide range during the tempering. The molecular changes which accompany tempering undoubtedly consist of a slow consolidation of the dispersed chromium, and carbon, into the complex double carbides which are gradually released from solution.

## *Summary*

The tensile properties, hardness and structure and the changes in these properties with different heat-treatments were determined for a series of chrome-vanadium steels. The series lends itself readily to a classification based upon changes in the concentration of carbon, vanadium or chromium.

The carbon group containing 1.0 per cent chromium; .18 per cent vanadium and varying in carbon from .15 to 1.20 per cent showed in the annealed state an improved tensile strength and a lowered ductility with an increase in carbon. In the heat treated specimens a similar effect occurs up to .60 per cent carbon.

Within the quenching temperature ranges investigated, the higher temperatures produce an improvement in tensile strength with an attendant loss in ductility. A rise in hardness accompanies the increased strength.

The vanadium group, containing .30-.40 per cent carbon; 1.0 per cent chromium and vanadium varying from 0.0 to .65 per cent, showed in the annealed state, an improvement in toughness, over corresponding carbon-

chromium steels. The tensile strength, is, however, but slightly affected. Heat treatment develops an improvement in tensile strength and hardness. The ductility as measured by the elongation, falls off rapidly when .30 vanadium is exceeded. The high reduction in area which is maintained over the entire group of vanadium steels, reveals, in the severe deformation over a localized section, the toughness or inherent ductility of the steel.

In the series of steels, containing .30-.40 per cent carbon, .18 per cent vanadium and 0 to 14.5 per cent chromium, the tensile, and hardness properties after annealing, remain quite uniform for increases in chromium up to 2 per cent. Chromium in excess of 2 per cent, increases the strength and hardness at the expense of the ductility. Heat treatment develops the influence of the element and intensifies the effects which are indicated in the annealed specimens.

The nature of the relation between the mechanical properties and the addition of different proportions of chromium, carbon and vanadium is suggested from an examination of the microstructures. In the annealed specimens, the well-known effort of chromium and vanadium to form carbides results in the combination of a portion of these elements with the cementite. The concentration of chromium and vanadium into complex carbides, causes a constriction and disruption of the pearlitic areas which in turn releases more ferrite and distributes the cementitic lamellae, more widely. The improvement in toughness of most of these steels is accounted for, by the release of a portion of the ferrite and the coincident reinforcement of the matrix by the distributed cementitic lamellae.

In heat-treating, higher quenching temperatures than those applied to carbon steels, are required to enforce the solution of the complex carbides. In steels containing a large amount of chromium, temperatures in excess of 1750 degrees Fahr. are necessary to enforce the solution of the complex carbides. Tempering produces the usual changes in structure which proceed, however, at a less rapid rate.

In conclusion, acknowledgment is due R. S. Tour, of the Fixed Nitrogen Research Laboratory, G. K. Burgess, of the Bureau of Standards and S. Tour of the Technical Staff, War Department, for the assistance that made this work possible.

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# RESEARCH FOR ENGINEERING SOCIETIES

By Alfred D. Flinn

## *Aims and Agencies*

RESEARCH is concentrated, directed endeavor to gain knowledge, new to the searcher. This paper is devoted to research in the natural sciences for the advancement of technology and industry under the auspices of the engineering societies. From the beginnings of human life necessity for sustenance and shelter has forced Man to learn more and more regarding his environment. In time it became desirable to go beyond the obvious,—to deduce and to predict. In the indistinct records of early civilization, evidences of the advancing search for knowledge are found, but the numbers engaged in the pursuit appear to have been very small. Progress in the remote ages was measured by milleniums. Then centuries began to count. Now the decades and even the days register advance so rapid that no longer is it possible for any individual to keep informed.

Great acceleration in research came with distinct improvement in means for social intercourse and for recording and disseminating knowledge. Each advance in science has increased the probability of other advances, not along the same lines alone, but also in other and frequently quite different fields. The number of workers, the variety and multiplicity of subjects and the diversity of applications have increased until the complexity has passed comprehension. Need for organization, co-ordination and co operation became urgent. But the initiation of these methods in research are but as of yesteryear. Only a very few of the world's oldest scientific societies have completed a century. Our oldest American engineering society was founded in 1848. According to the 1920 census, there are 136,000 technical engineers in the United States of America, exclusive of designers, draftsmen and inventors. The best available information gives about 150 national engineering societies, all more or less concerned with the advancement of the sciences and their applications to the well-being or destruction of Man.

A large number of these societies are actively engaging in investigations deserving the name "research." Frequently, however, these inquiries are questions of application or development rather than of research in fundamental science. This is natural and legitimate, for in the main, the engineer is concerned with applications and developments. Since the personal attainments, the care in operations, the equipment and the methods are often of the same order as those demanded by research in so-called pure science, the word research will be permitted in this paper to embrace both kinds of inquiry. Indeed, in many fields no sharp lines can be drawn between fundamental researches and inquiries into the applications of the knowledge gained. Indeed, in engineering, the art has frequently preceded the science.

The multiplicity of societies reflects variety of interests and also, to some degree, the tendency to create an independent agency for each new purpose. A few societies have important research departments. The tendency to independent action has some justification, but it has also

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A paper presented at the Detroit convention, Research Symposium. The author, Alfred D. Flinn is Secretary, Engineering Foundation and Chairman, Engineering Division, National Research Council.

led to dissociation of groups which have much in common, with consequent disadvantages. An opposite or integrating tendency has also been in evidence during recent years. Today it is found, therefore, that the engineering societies have numerous independent research activities, but that a number of them have established some means of co operation. First, there are a few societies, composed mostly of members of previously existing societies, which have been created principally for the study of a certain group of subjects and their applications in engineering and industry. By way of example, the American Society for Steel Treating and the Taylor Society may be mentioned in quite different fields. A second form of co-operation is the joint committee, with life ranging from weeks to years, representing from two to many societies and sometimes including governmental bureaus or educational institutions. Two co-operating organizations which are proving useful and important in promoting research will be described, Engineering Foundation and the National Research Council.

### *Engineering Foundation*

Ambrose Swasey, of Cleveland, Ohio, a leader among the mechanical engineers, eminent for his personal attainments, perceived the desirability of establishing for the engineering societies a fund and an organization to be devoted to research. In 1914, he offered the four national societies of Civil, Mining and Metallurgical, Mechanical and Electrical engineers, $200,000 as a nucleus of the proposed fund. This generous gift was accepted and committed to United Engineering Society, a board of twelve trustees, which had been created by the societies in 1904 and incorporated under New York laws, to hold and administer Engineering Societies Building and Library and other properties belonging to these societies jointly. At the request of these so-called Founder Societies, the United Engineering Society created a department known as the Engineering Foundation Board, to have full power in expending the income of the endowment. The high purpose which Mr. Swasey and those who collaborated with him in organizing the Foundation had in mind has been well stated as being the furtherance of research in science and in engineering and the advancement in any other manner of the profession of engineering and the good of mankind. Subsequently, Mr. Swasey made other gifts, bringing his total to a half million dollars. Assurances of legacies have been received from other persons.

The income of even a half million dollars does not go far in modern research projects. The scale is indicated by the fact that a number of enterprising American corporations have each been devoting annually from a few hundred thousand to three or four million dollars, not to mention the large sums appropriated for research by the Federal government. Nevertheless, by using its resources co-operatively, Engineering Foundation has to its credit a number of useful services. Its first co-operative project can hardly be excelled in results.

In 1916, some of the leaders in the scientific associations and engineering societies realized that the United States could not much longer refrain from participation in the World War. They also perceived that science, technology and industry were proving quite as essential to success in the struggle as were military skill and financial

resources. It was also evident that the three factors must combine in their efforts. Out of these convictions, through the medium of a meeting in New York, came the National Research Council, based on the charter of the National Academy of Sciences given by Congress in 1863, to bring together the scientists of the country for aid to the government in the war then in progress. When organized, National Research Council had no funds. Engineering Foundation had as yet undertaken no project. Its board at once offered the Council an office in Engineering Societies Building and the services of a secretary, devoting all its income for a year, besides funds specially raised. This prompt succor did much toward assuring the permanent establishment and success of the Council. The magnitude of the service thus performed by the engineering societies through the Foundation will appear in part from statements which will follow.

Engineering Foundation is a joint instrumentality of the engineering societies for the support and advancement of research. It is also a bond between scientists and engineers because it maintains its cordial relations with National Research Council. Besides its share in the establishment of National Research Council, the Foundation has to its credit a new form of weir for measuring water, resulting from experiments by Clemens Herschel; A director of hydraulic laboratories in United States of America, recently published; research in determination and measurement of internal stress in metal, now in progress in Columbia University Laboratories; an inquiry into the feasibility of establishing a testing station for large water wheels and other large hydraulic equipment; "Research Narratives", published semi-monthly since January, 1921. The first forty Narratives, recording instructive and interesting incidents in research and invention, have recently been done into a book for use in secondary schools and other educational institutions. In addition, a number of important preliminary investigations have been made, but lack of funds or other reasons have deterred the Foundation from undertaking the projects or carrying them through. Of these there may be named industrial education and training; mental hygiene of industry; organization among engineers; wear of gears.

The Foundation's co-operative projects are still among its most noteworthy; Spray concealment for vessels; fatigue phenomena of metals; directory of research laboratories in industrial establishments in United States of America; highway research; personnel research; corrosion of iron; arch dams; reinforced concrete multiple arches; wood finishing processes, including paints and varnishes; selected hydraulic problems. These projects range through various stages of progress from recent initiation to completion. Besides the National Research Council, the co-operators include industrial establishments, engineering offices, universities and technical societies. In addition, the foundation has been helpful to engineers, industries, societies and other organization in various parts of our own and other countries, and to a few governments in modest ways, for information and suggestions. Copies of the Foundation's Publication No. 4, containing a report for its seventh year and a report on research in Fatigue of Metals will be sent on request addressed to 29 West 39th Street, New York.

*National Research Council*

National Research Council is a co-operative federation of approxi-

mately eighty American associations concerned with the physical, mathematical and biological sciences and their applications to human welfare through the agricultural, engineering and medical arts. The stage of the world's development in which mankind could depend solely on individual geniuses for advance has been passed. The modern method is more rapid, surer of its path and more likely to succeed. A moment's reflection will convince one that co-operation in civilized communities is now general and inescapable amid modern social conditions although not always formal or organized.

By executive order of the President of the United States, in May, 1918, National Research Council was given permanent standing and the departments of the government were directed to co-operate. The council, however, is not and never has been a government bureau. Its financial support is assured in part by a gift of five million dollars from the Carnegie corporation, of which $1,350,000 is being devoted to a building in Washington. National Research Council also receives and administers funds for specific research projects. Since its organization such funds have totaled nearly two million dollars. In addition, funds for co-operative research projects have been provided, principally by the industries or organizations to be benefited. The council is prepared to act as treasurer for projects conducted under the auspices of its divisions. It is now performing this service for several projects of the Division of Engineering. Moneys so contributed are kept in separate funds, separately accounted for and applied only to the purposes designated.

Pending the completion of its permanent building, National Research Council has offices at 1701 Massachusetts Avenue, Washington, for all divisions excepting that of engineering, which has offices in Engineering Societies building, in New York, in order to facilitate co-operation with the societies and Engineering Foundation. The work of the council is performed by an executive board of approximately forty members, by numerous standing and special committees, a small office staff and the organizations of the divisions. The division of engineering aims to carry out the general purpose of the National Research Council in the field of engineering by furthering research and co-ordinating the work of existing agencies.. It seeks to minimize duplication wherever it is wasteful, to collect scattered efforts, to suggest programs for projects, to encourage individual initiative, to make knowledge gained more widely accessible, but not in any case to direct in the sense of dictating. The Division is made up of representatives of 11 national engineering societies, 17 members at large and a representative of the Division of Federal Relations, a total of approximately 40. The Division of Engineering makes itself useful largely through discovering engineering and industrial problems suitable for organized co-operative research; providing for the desired measure of supervision and advice to assure impartiality, authority and completeness for the investigation; serving as a clearing house and effecting correlation with kindred projects or sources of help. For counsel in various matters and for bonds with the societies, the division has an advisory board in each of the several large sectors of engineering, sponsored by one of the large societies.

Nothing can better illustrate the division's purpose and possibilities

than mention of some of its work done. But let it be said at once that the division does not claim full credit for any of the projects listed in its records—only that it has been helpful in some measure, greater or less. Fatigue phenomena of metals have been under extensive examination since the fall of 1919 at the experiment station of the University of Illinois, with the co-operation of Engineering Foundation and the General Electric company. A notable contribution was made to pyrometry by a committee co-operating with the American Institute of Mining and Metallurgical Engineers. Helmets and body armor, economy of manganese, steel ingot practice, deoxidizers for steel, hardness of metals, and uses of tellurium and selenium, are among the important metallurgical problems upon which committees of the division have worked. Large activities in other fields are in the hands of the Advisory Board on Highway Research, the American Bureau of Welding, with its ten active committees, the Molding Sands Committee working with the American Foundrymen's association, the committee on Marine Piling Investigations, enjoying the co-operation of the principal railroads having tide-water properties, several departments of the government, and other owners of marine structures. "Pulverizing," "electrical core losses" and "heat transmission," are titles of other active projects.

Pleasant and useful features of the division's yearly program are the three or four dinner meetings at the Engineer's club, in New York. To these meetings research men and executives of industries are invited and the time devoted to discussion of topics of practical interest to one or more industries, or branches of engineering. Though the division meetings and the meetings of its committees, much information of value passes directly from person to person by word of mouth and in correspondence. The by-products of the division's efforts are perhaps not the least important.

Besides engineering, National Research Council has six other divisions of science and technology; physical sciences, chemistry and chemical technology, geology and geography, medical sciences, biology and agriculture, and anthropology and psychology. Every one of these divisions deals with subjects of immediate interest to engineers. One of the greatest services of the research council is the maintenance of these liaisons among the varied branches of science and technology, to the benefit of each. These divisions provide or suggest suitable specialists for members on committees of the division of engineering, or otherwise co-operate. For example, there are biologists and chemists in the marine piling investigations, physicists in the heat transmission study, and in the fatigue of metals and welding committees, and geologists in the molding sand committee. Geologists have contributed also to highway research. Co-operation of medical men and psyschologists is indispensable in all studies relating to personnel in industry, a subject of great importance to engineers. Engineers and doctors are fellow workers in sanitation.

Furthermore, the council has six divisions of general relations: Federal, Foreign, States and Educational Relations, Research Extension and Research Information. Every one of these divisions has its engineering aspects or elements. The high character of these thirteen divisions and their scores of committees could best be shown by listing the emi-

nent scientists, engineers and men of affairs who constitute their memberships; but such a catalog of hundreds of names would be quite beyond the limitations of this paper. Mention will be made, however, of two divisions in particular, Research Extension and Research Information.

The Division of Research Extension, previously known as the Division of Industrial Relations, has among its functions, assistance in organizing associations for the conduct of research in industry and aid to other divisions, on their request, in planning and financing their projects. It has been instrumental in bringing into existence the American Institute of Baking, the Crop Protection Institute, the American Horological Institute, the board of Trustees for Critical Tables of Physical and Chemical Constants, and similar bodies. It has aided in planning other research organizations in the industries which have not yet been effected, such as the Alloys Research Association and a School of Tanning. It is endeavoring to further research in the cotton, woolen, tobacco, ceramic and other industries. It has managed for the Research Council important exhibits of wireless telephony and of the manufacture of explosives and their by-products. It has aided individual manufacturers with advice and suggestions regarding laboratories, research projects and sources of technical information.

Research Information Service is primarily a general clearing house for information concerning scientific and technological research. The chief purpose is to advance science and productive scholarship by supplying individuals, institutions or companies with desired information concerning results of research and allied activities. Every effort is made to avoid duplicating the work of other informational agencies and to co-ordinate and utilize their resources. It has published a directory of research laboratories in industrial establishments of the United States, a list of scientific periodicals which publish bibliographies and abstracts, a bulletin of funds available in the United States for encouragement of scientific research, and other pamphlets helpful to the promotion of interest in science and its services for engineering and industry. It is compiling and maintaining card lists of laboratories, investigations and personnel for scientific and technical research. The service may be used by any engineer, and even in its present stage of development, has been of assistance to hundreds of inquirers.

Research Information Service has under serious consideration the betterment of means for making scientific and technical information much more quickly, widely, completely and surely available. It would stimulate development of existing worthy agencies and creation of others to fill gaps. The plan under contemplation is not the establishment of a super-abstract bureau, nor the compilation of a great catalog of all scientific and technical knowledge, nor yet the collection of a superscientific library, but, rather, the assembling of information as to the locations and the conditions of use of all the repositories and sources of knowledge within the fields covered by National Research Council, and as to the indexes, catalogs, bibliographies and abstract journals which make this knowledge accessible to scientists and engineers. This division would create and maintain a "master key" or a "switchboard," or aid in organizing and financing a body to have these functions. There is no more needed conservation than that of scientific and technological knowledge. In other words, the proposal

under advisement is to establish an institution, ultimately to become as universally known as the post office, to which one who knows not where to find information on a given scientific or technical subject may apply with the assurance that he will be directed at once to the library, the laboratory, the organization, the governmental bureau, or the person from whom all the information, including the very latest, can be had, gratuitously, or for a proper compensation. Achievement of this purpose requires funds and time and the hearty collaboration of men well informed in the subjects.

The era is passing when from broad conceptions of engineering or from large engineering projects, the human forces can be omitted or "labor" be considered merely as one of the items regulated by market. Especially is this true of the continuing operations of industry and commerce. In many portions of this field of personnel, which comprises the whole gamut from management to unskilled labor, both science and art have made but little sure progress. Too many problems are yet argued on the basis of ill-informed opinion instead of being studied on the surer ground of ascertained fact. In an endeavor to promote the welfare of mankind in this field—than which none is of greater importance—Engineering Foundation and National Research Council after extended preliminary studies, organized the Personnel Research Federation. The object of this organization is the correlation of research activities pertaining to personnel in industry, commerce, education and government wherever such researches are conducted in the spirit and with the methods of science. It is endeavoring to create a clearing house for information in this field, to bring about harmony of effort and to formulate a comprehensive, advantageous plan. The Federation, however, needs additional support and co-operation. In spite of limited resources, it has made a good beginning and counts among its members several departments of government, leading universities, labor organizations, technical societies, and many individuals. It has established the Journal of Personnel Research, with a growing circulation. Its office is in Engineering Societies Building, New York. It has large and unique possibilities for usefulness.

So much for some of the agencies for research for engineering societies. But what are the aims? They are variously stated: the phrases are familiar. For example, "increase of human knowledge," "advancement of the Profession," "development of industry," "national defense." In most instances, these expressions of aim are material or at least intellectual in their implication. So far as they go, they are good; no unkindly criticism of them is even intimated. But man is more than a mechanism of brawn and brain, and this fact must be included in the planning of the engineer. Since art has always been ahead of science in most avenues of human progress—doing things before the fundamental principles were well known—the engineer especially bears responsibility for having put into the grasp of humanity instruments for a material advance which has far outstripped progress in government, jurisprudence, education, religion, and international relations.

Consequently, the possibilities for evil have grown apace with the potentialities for good. Scientists and engineers have been so engrossed in the main in gaining and applying physical facts that insufficient thought has been given to the sociological effects of the knowledge

gained. Enlightenment of the great body of the people in such ways as to make possible the safe assimilation of these facts and their fruits, has been neglected. Poet, priest, politician, jurist, teacher and artist are still too largely entertaining the conceptions and following the precedents of one, two or more centuries ago. Because it is peculiarly the function of the engineer to apply and adapt to the benefit of man the knowledge gained in the natural sciences and the mechanic arts, his studies should henceforth include the deep, subtle, far-reaching effects of his achievements upon social organization, taking into his contemplation not industry alone, and increase of material wealth and comfort, but also the spiritual well-being of all his fellow men. Any good, however ancient, should not be relinquished, but as our knowledge of good extends, these increments should be promptly incorporated into our ultimate purposes and our current practices. Research in science and engineering must be content with no lower aim.

# DURALUMIN—ITS PROPERTIES AND COMMERCIAL POSSIBILITIES

By William B. Stout

A MATERIAL one-third the weight of cold-rolled steel yet with the same approximate strength characteristics; a metal which can be heat treated to higher physical properties, yet by process which does not take effect for an hour after treatment; a possibility for much lighter and at the same time cheaper production in certain lines of manufacture—in a few words this is a picture of the future possibilities of the new copper-aluminum alloy known as duralumin.

Receiving its first impetus in the development of aircraft abroad, and particularly by the Zeppelin firm, this metal has been perfected in this country to a point far ahead of the German product, while the work in aircraft of both the airship or lighter-than-air type, and airplane or heavier-than-air machine, has developed processes and methods now applicable to new lines of production.

The new alloy can be rolled into sheets or forged by hand press or power hammer. It can be cast, welded and soldered, while rivets of the same material used with it show new production possibilities on account of the peculiarity of the heat treatment results. Connecting rods have been made of it using the metal itself for wearing surface without anti-friction metal. These have operated successfully in both motor cars and aircraft engines. Worm gears have been used made of "dural" as it is colloquially called, and used in heavy truck service successfully against steel pinions. Timing gears of this metal show new possibilities of both wear and quietness, but the most use has been in structural shapes for ultra-light constructions. The metal itself costs about five times as much as cold-rolled steel per pound. For production work, however, it must be remembered that but one-third the number of pounds is used for the same strength result, while the material, being much easier to work than steel in most of its forms, saves materially on labor tool cost and tool depreciation, and on enough production items so that in many cases constructions can be made cheaper of duralumin than of steel.

The work we have been following has been entirely along the line of minimum weight structures of fairly large size for aircraft work. The saving of a pound in an airplane structure means the addition of a pound of fuel in flight or a pound of pay load so that in aircraft, more than anywhere else, minimum weight is a vital item. However, strength is no less fundamental as an airplane in flight at speed is subject to stresses far greater than imposed on an automobile on the road or any other form of present transport. Imagine having to build a motor truck of 2-ton capacity that could run across a ploughed field at 70 miles an hour without breaking up. This alone would be some engineering problem, yet some modern planes of the bomb-carrying type are designed to do this.

Structures are now being built of duralumin which far exceed former strength figures in wood and yet which are lighter than any previous wood-and-cloth airplane constructions. At present there are in process machines capable of carrying 20 passenger at 2 miles a minute for 5

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A paper presented at a meeting of the Society. The author, William B. Stout, is president of the Stout Engineering Laboratories, Inc., Detroit.

hours, and fitted with 600 horsepower in engines, yet the whole machine weighs but the same as a Cadillac touring car. The entire secret of the weight is of course not all in the metal, but it is safe to state that the light weight figure could not have been reached with our present knowledge with any other known material.

Many have preferred steel in their experimental aircraft work on the basis that steel in tensile strength was stronger than duralumin even weight for weight. This is so, but the problem of strength in a structure is not ordinarily of tensile possibilities but of column or compressive strength. For the same weight duralumin has about three times the thickness of even its cold-rolled boiler plate counterpart, and five or six times the section of alloy steels of high tensile. The rigidity of a sheet is dependent largely on its thickness, and while dural is a much more flexible material than steel in equal section, yet with the greatly increased sections used for equal strength, a much greater rigidity is obtained than with steel.

For example, we have produced a rolled section, designed for a maximum column strength, and yet of such shape as to fit production requirements. This section of 0.035-inch thickness of metal in a 19-inch column length weighs 7½ ounces and will support as a column 4 tons plus. If made of steel of high alloy, its thickness would be, so far as tensile requirements go, about 0.009-inch, a too great fragility to be trustworthy in a structure on account of the lack of rigidity of such a thin wall.

Duralumin, as we see it, looks like aluminum except that it takes a high polish. The polish in ordinary atmospheres is permanent, the metal being noncorrosive to a high degree. In the tempered state it is almost impervious to salt spray, though in the annealed form salt water affects it. The chief difference between this and previous aluminum alloys is its property of having its physical characteristics materially changed by proper heat treatment. This heat treatment in itself acts differently than with other metals, leading to some peculiar production possibilities. Like all new things, this metal with its peculiar properties has certain assets and define liabilities, but even its liabilities, in some cases, can be turned to profit, provided the structures made of the metal are designed to fit the peculiar requirements of the alloy.

The most marked difference in the metal is that the change in physical properties following heat treatment is not instantaneous but arises gradually to a maximum after about four days, and during this period not only is the tensile strength increased, but the elongation may also increase. More than this, the metal in its heat treated form can be reheated and softened for passing through mechanical processes not of too violent a nature, and at the end of one hour come back to its original tempered characteristics. The fact that the extreme properties of the metal are not reached immediately, as in most metals, is of great advantage commercially, as will be explained later.

The heat treatment of the metal, or tempering, as it might be called, consists of heating the metal to 920-940 degrees Fahr. for from 7 to 30 minutes, the time being governed by the amount of metal in process. The material is then quenched in boiling water. It is then removed from the quenching bath and worked upon as soon as possible. In from one to two hours' time enough hardening will have taken place so that it will be difficult to work the metal. Where the time involved in making up the

piece does not exceed one hour and where the bendings or hammerings are not too severe, this process is a thoroughly feasible production method.

This allows us in our airplane work, for example, to heat treat a coil of sheet metal in a bath of sodium and potassium nitrates, quenching in an adjacent tank of boiling water, and uncoiling the sheet or strip, start it immediately through the rolls which form it into the shape desired, having the complete process over, and the spar ready for ageing within 20 minutes from the beginning of the operation.

It is not the author's intention to go into any of the technical details or metallurgical study of the scientific side of this new alloy, but rather to point out the numerous possibilities opened up by its use and to describe and explain some of the results and processes now being obtained with duralumin, primarily in aircraft work. It will be stated only that the metal itself is nothing other than a copper-aluminum alloy, the copper running about 4 per cent, and some magnesium, but with zinc as the most detrimental component. For this reason, duralumin is made only from the purest 99 per cent aluminum, so that the impurities in each of the alloys from which the metal is formed will not build up a detrimental quantity. It is the inability of the Germans to obtain pure aluminum which has hindered their duralumin alloy from equaling the figures obtained in every day production from the American product. The composition and physical properties of duralumin are shown in the accompanying table.

**COMPOSITION AND PHYSICAL PROPERTIES OF DURALUMIN**

**Chemical Composition**

| | Per cent |
|---|---|
| Copper | 3.50-4.00 |
| Magnesium | 0.20-0.75 |
| Manganese | 0.40-1.00 |
| Aluminum, 99 per cent pure | Balance |

**Physical Properties**

| | |
|---|---|
| Specific gravity | 2.80 |
| Weight, per cubic inch | 0.102 |
| Melting range, degrees Cent. | 540-650 |
| Compressive strength tempered, pounds per square inch | 44,000 |
| Shear value tempered, pounds per square inch | 30,000 |
| Tensile strength tempered, pounds per square inch | 50,000-60,000 |
| Elongation tempered, per cent | 16-20 |
| Modulus of elasticity, pounds per square inch | 10,600,000 |
| Coefficient of expansion, per degree Cent. | 0.0000226 |
| Yield point, pounds per square inch | 30,000 |

The metal itself, however, was developed in Germany from an original French laboratory development. The first real commercial use to which it was put, so far as the public was concerned, was in the metal ships of the Zeppelin company. One of the reasons for the slow development of the Zeppelin, aside from the problems of airship design itself, was the necessity of developing the metal along with the structure, and it is certain that the material, unless rightly handled, has many idiosyncracies.

In the early metal, considerable trouble was had with corrosion and with sheets, seemingly without reason, granulated; and until the properties and difficulties were worked out, structures built of the material were

more or less uncertain and required frequent inspection. This is still true in thin gages which are not carefully heat treated, but with pieces of any real section corrosion is now an almost unheard of thing.

In the following outline the author will give merely experiences with the present liabilities of the material and things to be watched out for in its use, but in criticizing he would, at the same time, state the belief that duralumin and derivatives which will spring from it will form undoubtedly the mainstay of all future lightweight developments in automotive and kindred structures, and that the use of this metal will grow by leaps and bounds as its marvelous advantages in both structure and production become generally known and understood.

The main trouble found with duralumin is more or less similar to the problem met in other alloys, that is, the presence of impurities in the ingot, or air bubbles, small in their original forms, but which, when worked out and forged into thinner sections, developed into serious defects. Most of our material is of 0.035-inch stock, so that a small speck of dirt can make a serious flaw in the metal sheet and a small air bubble can make a considerable pipe in the center of the sheet, almost impossible to find except by microscopic examination.

Most of these flaws do not show up until after the rolling as in the case of an intricate chord section. In this case, the greatest stress on the metal in putting it through the rolls is at a hidden point, so that to inspect these spars or chord members a dental mirror is used with a high light, and the surface carefully examined. Frequently a hole as small as the point of a fine needle can be opened up into a flaw 5 inches long—a sort of stratification of the metal, resulting from original ingot impurities.

At the beginning of our work spar rejections, for this reason, ran as high as 80 per cent, this gradually being reduced, and it seems possible in the near future that the rejections will be normal. In all these sections there has been no attempt at drawing the metal, but merely bending it, as any attmpt to draw the metal results in an extreme number of rejections through cracking. It is peculiar that these cracks may not appear until a number of hours after the piece is made, so that after rolling, four days is allowed to elapse before parts can be inspected for cracks or flaws, or before any piece is allowed to be put into the actual airplane structure. In the design of the rolls, great care must be taken also against too great a degree of draw between annealings, and that all radii are of sufficient amplitude for the metal.

The great drawback of the material as we are using it at present, is the presence of ingot flaws, rolled out in the sheet which lead to this high rejection cost. When this is cured it can be said that the experimental stage of duralumin is over. As soon as quantities of the material are demanded, rolls can be put in for greater widths of sheet than at present available—16 inches being now the best obtainable—and tubing and other structural forms can be made available.

It is believed that this material, and developments from it in better alloys, eventually will be more universally used than steel for structural requirements. Its use in aeronautics is already definitely established, new as its use is, and the all-metal plane already is given preference to the older types. It is believed we will next see it in motor cars, at a saving of over half the weight, and in boats and busses, street and railway cars, bridges and girders. For the time being, however, it is a material

to watch and study, and to make use of conservatively in conservative lines of engineering, but in ultra-progressive fashion in those industries like aircraft where reduction of weight is a vital element of safety.

### Discussion of Mr. Stout's Paper

MR. THUM: The number of rejections that you gave, is that the number you got when you started out?

MR. STOUT: We got one good spar out of about five.

MR. McCLOUD: You spoke of the possibility of soldering duralumin. About how does it compare with aluminum as to the ability to solder it readily? Is it much more easily soldered than aluminum, or does it present much the same difficulties?

MR. STOUT: It presents about the same difficulties. The only places where we have considered soldering at all is for waterproofing joints. Naturally a soldered joint will not pull anywhere near what the duralumin would, but we have soldered adjacent to a riveted joint in order to waterproof. It is fairly easy to solder.

MR. PORTER: Is the material suitable for use where it is liable to vibrate? I would like to know whether or not it has a vibratory stress.

MR. STOUT: Like other metals, that is a question of design. Anything designed of too little strength will be affected by vibration in proportion, but the vibration tests that have been conducted by the navy and also by the army show a little higher resistance to vibration than cold-rolled steel.

MR. STAFFORD: Have any experiments been made along the line of making seamless tubing?

MR. STOUT: Yes, the Germans are practically the only ones who have done it, due to the fact that the process involved requires a great deal more power behind it than the steel tubing. You can't use the same machinery and produce it.

MR. STAFFORD: It can be done?

MR. STOUT: It can be done. The tubing can be purchased in Germany.

# FEDERAL AND STATE RESEARCH AGENCIES

By W. M. Corse

NOTHING remains continuously the same. Hence, there is no limit to research. The non-thinking man may believe that available knowledge comprises nearly all that may be known, but the thinker recognizes that he lives in a world which we understand but imperfectly. Our own country, as well as the whole world, saw the national importance of science and research in the early days of the great war. Problems arose immediately that were soluble only through scientific research. And Germany gave us evidence of her appreciation of this fact by her high state of preparedness, which admittedly was due to the fact that for nearly half a century she had been a nation given to investigation in a great variety of little explored subjects, but which made her a giant in strength in the face of the Allied Powers.

The United States, however, was not without its scientific research agencies. But these have always been cramped in view of their economic importance. When one single disease of wheat—the black stem rust—will destroy two hundred and eighty million bushels of wheat in a single year in the United States and Canada, and the boll-weevil takes its toll of millions of acres of cotton, the complaint of expenditures in the Department of Agriculture by the politicians seems rather stupid to an intelligent man who sees these same politicians voting away millions for less useful purposes. Figures just made public show that from a point of loss in production of cotton through all causes, 1921 was a record year. The estimated production of cotton in the United States aggregates 18,666,000 bales. There should be added to these figures 10,712,000 bales, which were not produced for one reason or another, for which the boll-weevil was responsible for 6,277,000 bales in one year alone. When we consider that the average export of cotton for ten years was 7,456,000 bales and our domestic consumption was 6,396,000 bales we can begin to appreciate the actual loss in dollars yearly from the presence of this pest.

Although you may already be aware of it, it might be well to repeat that in 1920 the budget showed an expediture of 1 per cent by the federal government for research, education, and developmental work as against 92.8 per cent for obligations arising from wars and expenses of the War and Navy Department and Shipping Board, 3 per cent for public works and 3.2 per cent for primary governmental functions such as Congress, the Presidency and the various departments. Just about 50c of the $50 expended per capita per annum by the federal government goes for research, education, and developmental work.

What are the government agencies for research, and what do they do? Necessarily in the brief time at my disposal I can but look at these in a cursory manner. As a general statement it may be said that in each department of the government there is some research function. Even Senators and Congressmen are supposed to be acquainted with facts, and some of them do make an effort to get these. The Department of State has its Division of Foreign Intelligence and its Division of Political and Economic Information. The Department of Justice, of course, is a department where investigations in many ways go on. In

A paper presented before the Detroit Convention Research Symposium. The author, W. M. Corse, vice chairman, Division of Engineering Research, National Research Council.

the Department of Labor there is the Bureau of Labor Statistics, which collects information on the subject of labor, its relation to capital, the hours of labor and the earnings of laboring men and women, and the means of promoting their material, social, intellectual and moral prosperity. The Children's Bureau was established by Act of Congress to investigate and report upon all matters pertaining to the welfare of children and child life. And the Women's Bureau has for its function to report upon all matters pertaining to the welfare of women in industry, and based upon such investigations to formulate standards and policies which shall promote the welfare of wage-earning women, improve their working conditions, increase their efficiency and advance their opportunities for profitable employment.

The Bureau of Efficiency is a scientific research bureau along economic and personal lines to improve the business methods of various branches of the government service. The Bureau of Education has for many years been engaged in statistical and other research that would give a record of the educational work of the country. Even the Federal Reserve Board and the Railroad Labor Board have functions of research. The former has a special Division of Analysis and Research, its purpose being to determine the per cent of the total expenditures going toward food, rent, clothing, etc., of a typical family or individual in each salary group in order to give proper weighting to the price changes reported by the United States Bureau of Labor Statistics at intervals of six months. The Railroad Labor Board makes studies, of course, of conditions upon which it bases its decisions. These are merely typical of general research work by Federal agencies.

But the group of men before me is more interested in the more fundamental scientific research being carried on by the government in what are distinctively scientific bureaus. The most widespread work is that of the Department of Agriculture, under which we find such bureaus as those of chemistry, entomology and plant pathology, for example. These are distinctively scientific investigation bureaus, though of course, a certain amount of adminstrative and control work is done by them. The Bureau of Chemistry, for instance, sees that there are no contraventions of the Food and Drugs Act. The Insecticide and Fungicide Board has charge of the prevention of adulteration and the wrongful labeling of remedies for the control of plant diseases and injurious insects. The Forest Service is not statistical in its work, but engages in definite research work towards the preservation of the wood of the country and its better use. The Bureau of Soils makes a scientific study of all conditions of the soils of the country. And the Bureau of Public Roads is engaged in developing through definite research and test work the best kind of road used under a given condition. The work of the Department of Agriculture is so broad that I am not attempting to more than indicate part of what it is doing.

The Department of Commerce is likewise engaged in research work. Through its Bureau of Fisheries it is seeking to understand the best conditions for maintaining and increasing the value to the nation of a great natural food product. The Bureau of the Census makes, of course, statistical researches which have varied uses. The Bureau of Foreign

and Domestic Commerce aids American industries through its investigations of countries abroad and opportunities of the extension of American commerce.

The Bureau of Public Health is one of the most important of the agencies doing work of research and education. It is in the Department of the Treasury. It does not only maintain supervision of incoming vessels to prevent the introduction of disease and acts in other ways for similar purposes, but carries out scientific research to develop methods for preventing the spread of the disease.

But there are three branches of government service that appeal particularly to you men whom I am addressing, for these agencies have special concern, among their other functions, with investigations and researches in steel. These are the Bureau of Mines of the Department of the Interior, the Bureau of Standards of the Department of Commerce, and the War and Navy Departments.

The research work in the Army and Navy is chiefly the work of the ordnance departments, the Air Service, the Signal Corps and the Chemical Warfare Service. As a sample of the work done in the Ordnance Laboratory at Watertown Arsenal, one might mention such investigations as the following:

An examination of castings having different manganese content;

An examination of high manganese steel castings to determine the chemical composition and microstructure of this steel;

Experimental heat treatment of cast steel to determine the effect on the physical properties, including the Charpy impact strength of three standard heat treatments applied to cast steel in the Arsenal foundry;

Investigation to determine the effect of phosphorus upon the properties of cast steel with particular reference to the shock strength;

Compressive tests of copper cylinders for pressure gages.

But the Bureau of Mines and the Bureau of Standards are the agencies of the government which go more deeply and widely into investigations which we think of as strictly fundamental research. The work of these Bureaus overlaps to some extent, but on the other hand each has its specific work. The Bureau of Mines, according to its organic act, is "to make diligent investigation of the methods of mining, especially in relation to the safety of miners, and the appliances best adapted to prevent accident, the possible improvement of conditions under which mining operations are carried on, the treatment of ores and other mineral substances, the use of explosives and electricity and other inquiries of technologic investigations pertinent to said industries."

For a number of years Dr. Gillett, and his co-workers of the Ithaca Field Office of the Bureau, have been carrying on work on the experimental production of alloy steels. These included those steels containing zirconium, titanium, uranium, boron, and cerium. They found that when the raw material used is sufficiently low in sulphur and phosphorus to obviate the making of refining slags, and straight melting, analogous to crucible steel practice, is done, the making of special alloy steels in 50 to 100 pound heats, to chemical specification, is relatively

simple in a 50-kilowatt indirect-arc furnace after the behavior of the ferroalloys to be used is known, and the behavior of such alloys can be conveniently studied with the furnace.

One of the objects of this investigation was the recovery and segregation of the different alloying elements. Some of the steels prepared are of rather unusual composition, many being nickel steels high in silicon. No general conclusions are drawn as to the value of the various alloying metals above mentioned in commonly used types of steels. The results of the physical tests so far obtained on steels of which these elements are present in appreciable percentages have not in general been promising. In plain steels of low carbon content to which less than one-fourth of one per cent of zirconium has been added, it seems that zirconium may have a beneficial effect, especially on notched-bar impact tests. Even in small ingots noticeable segregation of uranium, or cerium generally appears when over about one-half of one per cent of the first, or about one-third of one per cent of either of the two latter is present in the steel. These readily oxidizable elements are best added in the ladle, or to the furnace immediately before pouring. In remelting scrap containing these elements, they will be almost wholly lost, even in electric furnace melting. Uranium and zirconium alloys used to introduce these elements into steel should be as free from carbon as possible. Alloys of zirconium with silicon or nickel, or both, give fair recoveries of zirconium, but no ferro-zirconium tried does give recoveries of zirconium. Titanium does not segregate as readily as zirconium, and its recovery from the ferroalloy is higher; but in large amounts it is likely to segregate. The addition of a more readily oxidized element, such as zirconium, seems to help on the recovery of titanium. Although these elements are readily oxidized, none of them appear to be as efficient as aluminum or vanadium in degasifying "wild" steel. Dr. Gillett, in his work, made no special study of the use of small amounts of these elements as scavengers only. Boron is almost quantitatively recovered when added at the end of the heat, and may be added at the start of the heat without great loss. In the amounts studied up to three-fifths of one per cent, no appreciable tendency to segregation was noted.

The Ithaca Office has also studied molybdenum steel, especially with reference to whether molybdenum steel has properties which makes it a possible substitute for vanadium steel, or whether it has any properties of its own which make it valuable. No results of the tests on molybdenum steel are yet available to the public. In the determination of the physical properties of these steels, the results indicate the necessity of studying the properties of "clean" metal versus "dirty" metal. In other words, the study of the effect of included solids in the steel. The results of the physical tests show that in certain cases at least a clean steel will give tests from 100 to 1000 times as great on Upton-Lewis machine as a dirty steel of the same composition.

At the present time the Ithaca Field Office is concerned in tabulating and plotting tensile, impact and repeated impact tests on molybdenum, cerium, and other alloy steels obtained during the last two years. The endurance results so far obtained will be similarly dealt with shortly. It is hoped that very soon experimental work will be carried on to determine the affect of inclusions in steel alloys and also in brasses and

other copper alloys. These are just by way of samples of the important research work that is being done by the Bureau of Mines.

The Bureau of Standards is more concerned with the development and maintaining the standards of length, mass, volume, temperature, electrical and optical measurements and in the preparation of standard chemicals. Its name itself characterizes the prime reason for its being. A very large amount of work is done for the army, navy and other governmental departments and for state institutions.

The Bureau is much broader than the metal field, dealing with textiles, leather, rubber and a great variety of products. In the field of metallurgy it concerns itself with experimental research and the acquirement of knowledge in fields relating to products metallurgy as distinguished from process metallurgy. But in mentioning some of the important problems which have engaged its attention during the past year I will confine myself to the working of the Metallurgical division, and even here can but touch upon its program. A full report of last year's work will be released. I understand, in November. Particular attention has been given to the study of the methods of analyses for gases in metals. As you all know this is one of the most baffling subjects in all the fields of metallurgy. The main object in view has been to devise methods for the elimination of the harmful effects of gases in metals. A study was also made of deoxidation processes in steel and iron manufacture. Thermal stresses in chilled iron and steel car wheels is a study of particular interest to the railroads; and attention has been given also to the effect of using titanium in rail steel manufacture. The division will now give attention to methods of abrasion testing, having recently completed its first program relating to bearing metals. Under a joint committee an investigation has been carried out on the effect of sulphur on several grades of steel, and a preliminary publication has been issued dealing with the relation of the sulphur content to the properties of rivet steel. Other publications soon to appear will give results of a study of the rolling characteristics of medium carbon steel, the properties of pure alloys of iron, carbon and manganese, and the testing or wrought iron. Investigations started are the corrosion of rust-resisting chromium and other steels, the preparation of platium alloys and the comparison of the cutting qualities of high-speed steels, and, through the instrumentality of joint committees, investigations relating to gage steels, mine drill steels, molding sands, welded rail joints and thermal stresses in steel wheels. During the past year the division did further work with magnetic methods for determining critical ranges in steels with varying degrees of success, and tests were made of made of quite a number of commercial carbon and alloy steels and metals of special composition throughout the range 20 to 550 degrees Cent. Tests of the effect of heat treatment of some of the newer alloy steels were also continued. But here again I must state that it is quite impossible to even sketch in the time allotted for this paper a tithe of the work that is done at the Bureau of Standards.

Before considering briefly the research work in the states it may be well to say that the word "research" is often used by the average man with much less meaning than the scientist gives to it. Simple investigation and routine testing often pass for research. According to the scientist's definition of research there is not a great amount of research

work being done by the state governments. Most of it is in the agricultural colleges. A number of states are also interested in geological investigations and others have fish commissions, but the condition in the great majority of states is by no means what it should be.

The National Research Council, through its Division of States Relations, has been securing data about the facts of the case, and I may refer to reports which have been made to it upon surveys of Illinois and California, as showing some of the things that are lacking. These two states are among the foremost in educational and research work. The report of California says that the administrative agencies of the state engaged to a limited extent only in the work of scientific research. They are primarily concerned with administration of previously ascertained standards, having either not the time, or facilities, or the inclination to submit their processes to the test of systematic reinvestigation. It was stated by an official of the California Department of Agriculture, one of the very few agencies in which research proper is carried on, that its work was "90 to 95 per cent administration; 5 to 10 per cent research." Great reliance is placed by nearly all the state agencies upon the institutions of higher learning of the state, especially upon the University of California.

In Illinois the research agencies of the state are the State University, the Bureau of Tests of the Highway Division of the Department of Public Works and Buildings, the Geological Survey, Water Survey, the Natural History Survey, the Psycopathic Institute and the Institute for Juvenile Research.

The following recommendations were made by Dr. Leonard D. White, of the University of Chicago, who made the survey for the National Research Council of the conditions in Illinois.

1. Research should be recognized as a specialized function and clearly differentiated from administration.

2. The State University should be recognized as the central research agency of the state government.

3. Greater opportunity to develop a prefessional esprit de corps should prevail.

Affiliation with the University would work in this direction. Closer contact with the Illinois Academy of Science may likewise be recommended. A professional esprit de corps would be stimulated by the establishment of professional associations with regular meetings at which attendance should be expected and for the expenses of which the state should provide.

4. The co-ordination of research should be further organized. Such co-ordination might be brought about by the establishment of a state council on scientific research. This council should be composed of the heads of the research departments of the State University, the heads of the scientific bureaus and agencies, representatives of the departments of administration and of finance, and representatives of industry so far as relevant to the purposes of the council.

5. Special attention should be given to popularizing the research function in order to lay the permanent foundation for legislative and financial support.

6. The scientific personnel should be placed on a permanent nonpartisan basis and should be free from administrative duties. This result would be attained by consolidation or affiliation with the state university. All requirements of residence in the state as a prerequisite to appointment should be abolished. The salary scale should be the equivalent of that maintained in the state university for persons of similar professional attainments.

In most states there are the usual scientific agencies, boards or commissions of conservation, forestry, fish and game, public health, mines, the geological survey, a department of agriculture, etc. Many of these are provided with facilities which enable them to engage actively upon research problems connected with their administrative work. But there is a possibility for much greater development of the research function in the departments of our state governments.

Primarily the matter seems to involve a clearer understanding than we now have of the sources to which the scientific departments of a state government ought to look for research assistance in meeting their administrative problems. In most states practically all of the agricultural research work of the state is done by the state agricultural college, working in close co-operation with the federal Department of Agriculture. The state university also is a great resource for research and should be so related to the state government as to permit the utilization of its reseach capacity for the good of the state without interfering with the proper educational functions of the institution. We should be in position to insist on increased support or research on the part of the state government if it could be said that all of the research resources of the states were so co-ordinated as to permit of their utmost legitimate utilization for the commonwealth and if we could have a clear recognition of the type of scientific work which ought to be undertaken by the various agencies and the type of work which can best be carried on co-operatively with the federal government or jointly with other states.

The importance of real fundamental research work to the nation is being more widely appreciated, but is not yet understood as it must be if we are to maintain our place among the nations. The fact is that in every manufacturing country the importance of research in relation to industry has come to be realized more strongly than ever. I am speaking not of the scientist's outlook, which essentially embraces the fields of research, but rather of the recognition of the practical value of research by manufacturers and by the thinking public generally. Nations abroad are establishing research institutions. Germany's preparedness both for war and for industry has opened the eyes of big business men. Dr. J. J. Carty, vice president of the American Telephone and Telegraph Company said in his presidential address to the Institute of Electrical Engineers in 1916, "By every means in our power, therefore, let us show our appreciation of pure science, and let us forward the work of the pure scientists for they are the advance guard of civilization. They point the way which we must follow. Let us arouse the people of our country to the wonderful possibilities of scientific discovery and to the

responsibilities to suppport it which rests upon them, and I am sure they will respond generously and effectively."

Other prophets have called us to follow the same course.

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## What Is The Matter With The American Railroads Today?

(*Concluded from page* 184)

railroads, and during the strike, will certainly be recorded as extraordinary. There is, in my judgment, no other business that could survive as the railroads have, under the attacks that have been centered upon them.

The relief lies in less regulation and in removing the railroads from politics. Repeal the useless and extravagant regulatory laws that exist only for the purpose of making political jobs for the faithful and for the parasites of union labor. The people should give a mandate to congress that will compel, forever, the demagogues, to keep their bungling and paralyzing hands off transportation and the great industries of the country.

# ADVANTAGES OF THE FORGED MILLING CUTTER

By William G. Calkins *

AS A result of the rapid strides which have been made in the past few years in increasing shop efficiency and production, a demand has arisen for a superior grade of milling cutter; one which is able to withstand the highest rates of speed and feed without excessive deterioration, thereby removing metal at the lowest possible cost per unit.

The beneficial effect on steel conferred by the proper forging and mechanical working at correct temperatures is well known. It must be borne in mind, however, that the forging of high speed steel is an operation requiring a high degree of experience and ability and the operation cannot be compared with the ordinary drop forging of low carbon alloy steels similar to those used in automobile construction.

By the term "high speed steel" we refer to a steel of the high tungsten, high chrome type which has been adopted by the majority of the reputable tool manufacturers as the material most suitable for the manufacture of the highest quality of cutting tools. The following are excellent minimum and maximum limits for the principal alloying elements in such a steel:

| | Per cent | |
|---|---|---|
| | Minimum | Maximum |
| Carbon | 0.65 | 0.75 |
| Tungsten | 17.00 | 19.00 |
| Chromium | 3.50 | 4.50 |
| Vanadium | 0.75 | 1.50 |

This specification does not preclude the possibility of making tools which will perform satisfactorily from the so called low or 14 per cent tungsten steels for certain operations, but where the utmost limits of endurance are required in drilling or milling operations the 18 per cent tungsten steel invariably will prove to be superior. The average performance of all the 14 per cent tungsten steel drills which have been tested in the plant with which the author is connected has been from 60 to 75 per cent of the maximum obtainable from drills made from the high tungsten type. Conditions in planing operations are somewhat different and some of the largest machine shops in the country favor the low tungsten steels for this type of service.

Two methods of manufacture are to be considered in making high speed milling cutters: 1. Direct cutting from bar stock; and 2, upset or forged method. Before attempting to outline the advantages of a forged cutter as compared to a cutter made direct from the bar stock, some consideration must be given to the process of manufacture of high speed steel with special reference to the internal structural condition.

High speed steel whether made by the crucible or electric process is cast in the molten state into iron ingot molds. The side of the ingot will ordinarily vary from 3 to 12 inches square with rounded corners and made slightly tapering. It is essential that the ingot be cast as nearly perfect as possible and special attention must be given to the prevention of excessive pipe, blowholes, segregation of certain constituents, etc. Piping is the term applied to the cavity which forms in the top portion of

* A paper presented before the Society. The author, William G. Calkins, is Metallurgist, Detroit Twist Drill Co., Detroit.

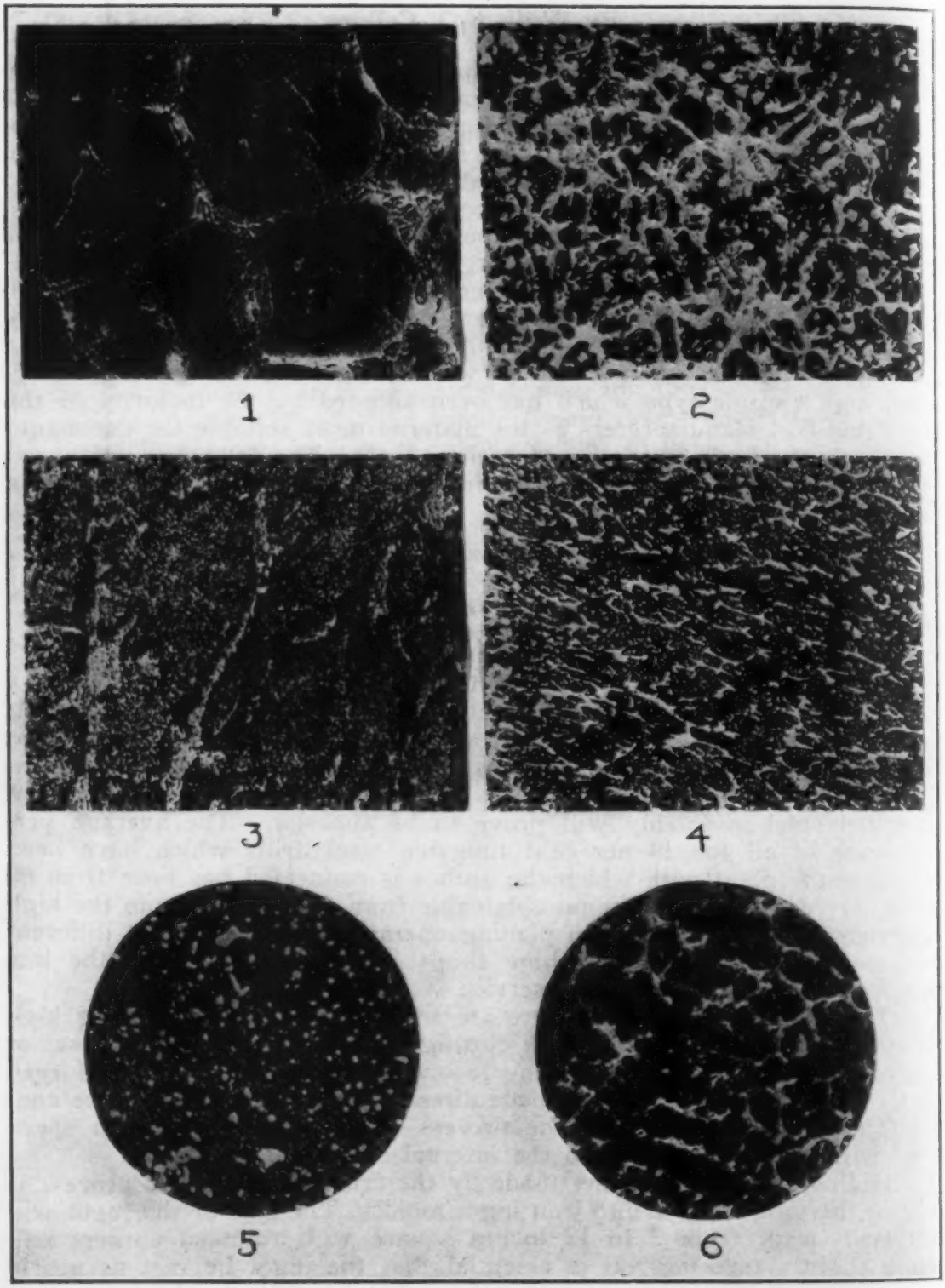



Fig. 1—Photomicrographs of a high speed steel ingot as cast. X 250. Fig. 2—The same as Fig. 1 but X 50. Fig. 3—Photomicrographs of a high speed steel billet. X 250. Fig. 4—The same as Fig. 3 but X 50. Figs. 3 and 4 show the effect of reductions as compared with the ingot structure of Figs. 1 and 2. Note the remnants of carbide envelopes. Fig. 5—Photomicrograph of ⅞-inch annealed high speed steel bar stock. X 250. Fig. 6—Photomicrograph showing center of a 6-inch round. X 100

the ingot due to shrinkage as the ingot cools and solidifies. The central portion of an ingot, due to the fact that it is last to solidify, always contains the least desirable structure, being more coarsely crystalline than the outer portion and also subject to segregation of impurities, slag, etc.

When a section of high speed steel is polished, etched and observed under the microscope highly magnified, it appears to consist of at least two separate and distinct components; one of which is dark in color and the other light. Figs. 1 and 2 illustrate the structural condition in the interior of an ingot as cast. Attention is called to the coarse crystalline condition and so called "carbide envelopes" or cellular structure. Steel showing this structure is not suitable for use in cutting tools. These carbides are probably mixed complex tungstides and carbides of iron, chromium and vanadium, concerning which the exact chemical formulae are not definitely known.

The high speed ingot is then annealed, primarily to assist in emulsifying the cellular structure and to remove internal strains caused by cooling and contraction; also to enable drillings to be taken for purposes of analysis. The next operation is the removal of surface defects such

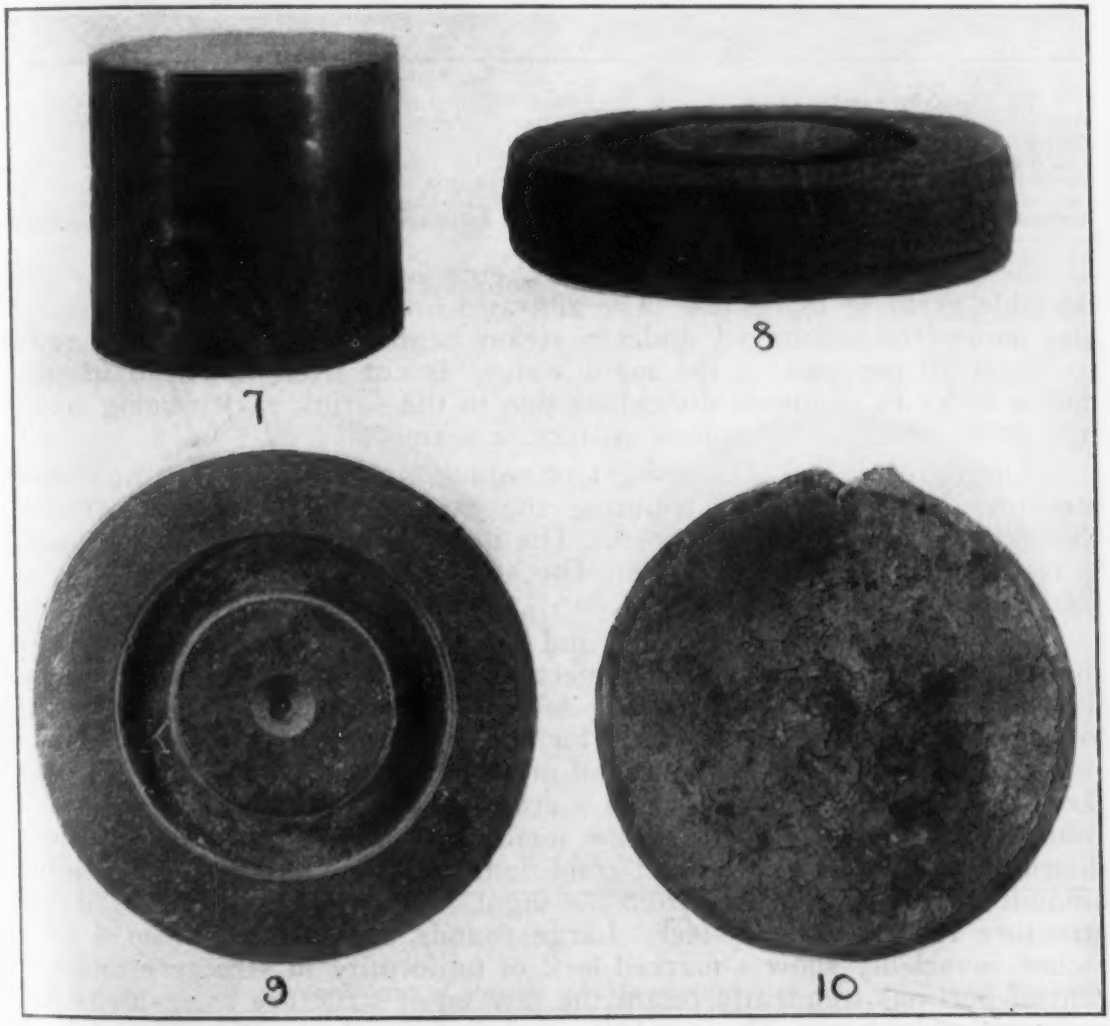



Fig. 7—A piece of round stock ready to be forged into a cutter blank. Fig. 8—The blank as it appears after the forging operation. Fig. 9—A finished high speed steel milling cutter blank. Fig. 10—Forged high speed steel disk showing radial crack developed by hammering between flat-faced dies

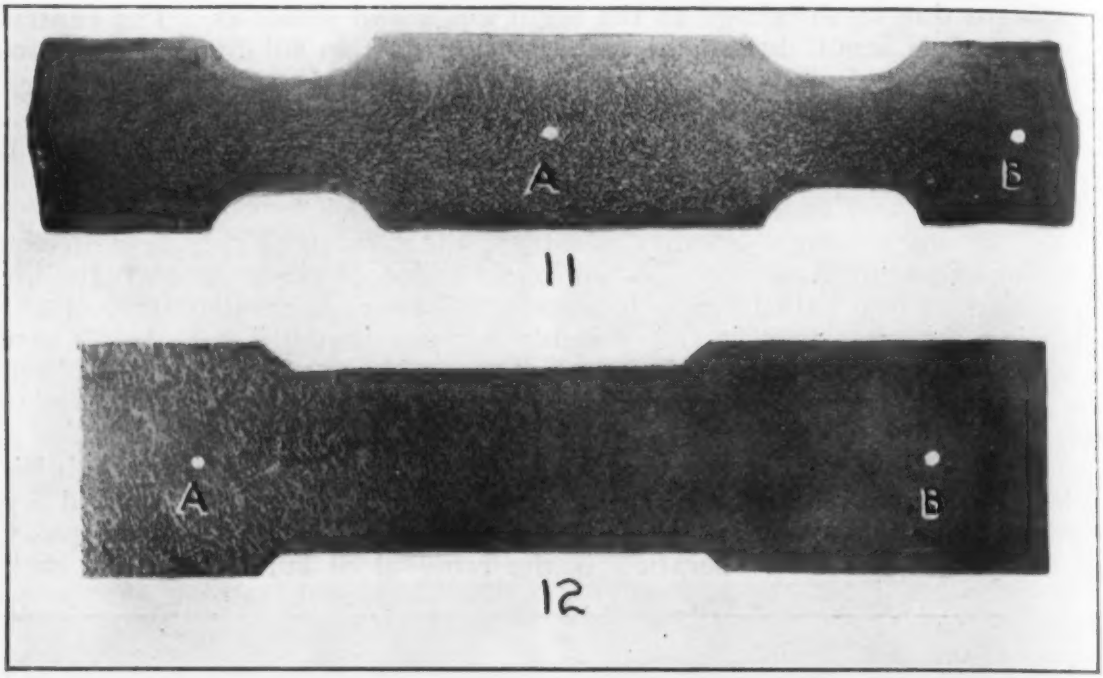


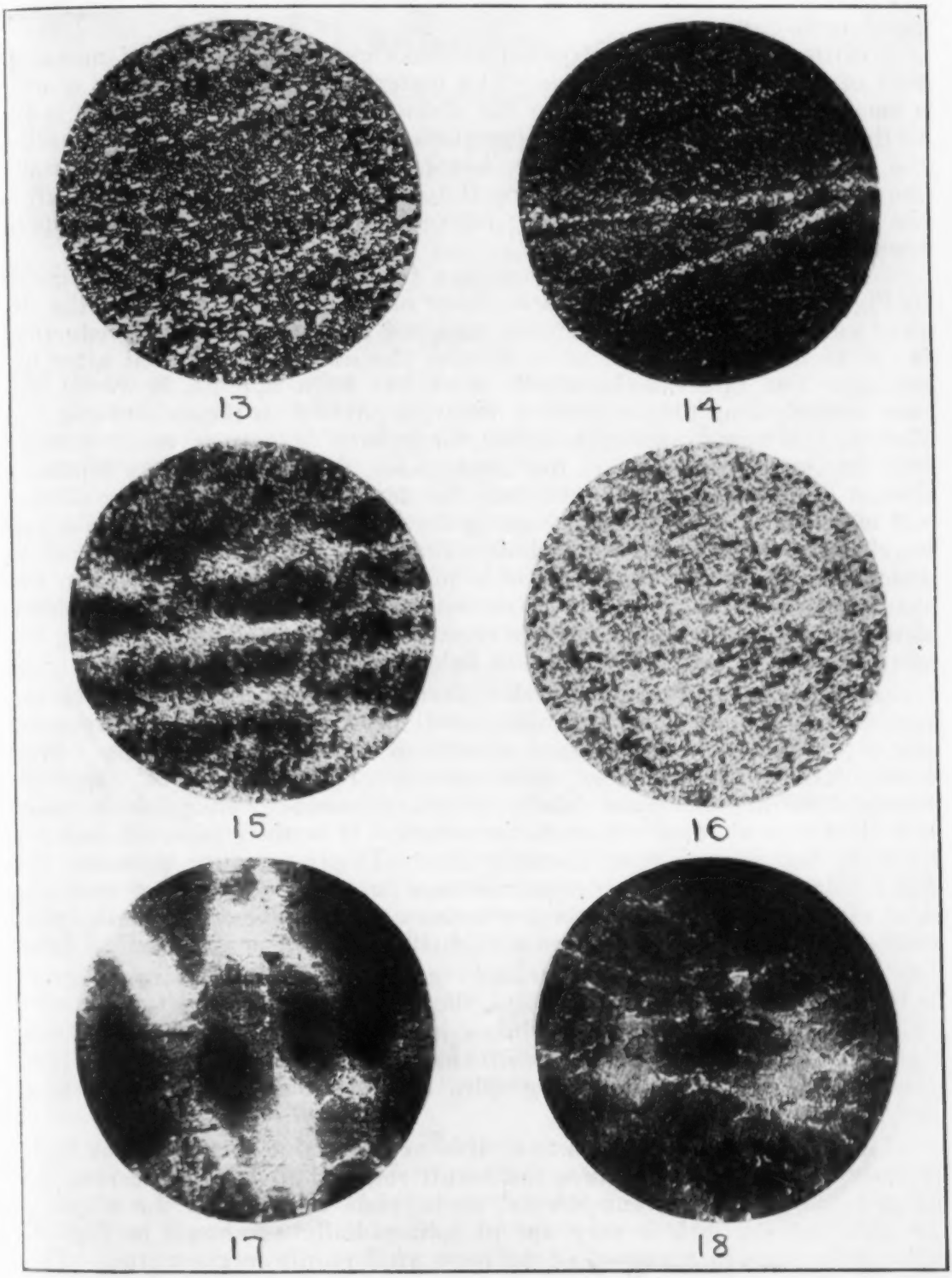

Fig. 11—Cross section of forged high speed steel milling cutter. Polished and etched to bring out structure. Note ring of fine grained dense metal extending around edges of teeth and more open grain toward the center. This is actual direct photograph without retouching. Photomicrographs of points *A* and *B* are shown in Figs. 15 and 16 respectively. Fig. 12—Cross section of high speed steel milling cutter made from bar stock. Note coarse crystalline condition showing dendrites or pine tree crystals indicative of lack of sufficient reduction and mechanical working of the steel. This structure is not desirable for cutting tools. Photomicrographs of points *A* and *B* are shown in Figs. 17 and 18 respectively

as checks, blowholes, slag inclusions, etc., by grinding them out with portable grinding machines. The annealed and ground ingot is reheated and hammered or cogged under a steam hammer and an amount equal to about 20 per cent of the ingot weight is cut from the head or pipe end in order to eliminate difficulties due to the shrink cavity being rolled into bars, thus causing hollow centers or seams.

The effect of the hammering and reduction is to break up the coarse structure, refining and distributing the carbide and tungstide particles throughout the mass of the steel. The ingot after cogging and cropping is technically known as a billet. The structure of a high speed billet is shown in Figs. 3 and 4.

The billets are then annealed and ground in the same manner as the ingots and delivered to the hammers or rolls, as the case may be, for final finishing to shape and size. After hammering or rolling, the bars are again annealed and are ready for the market.

The microstructure of a piece of properly worked annealed high speed steel is shown in Fig. 5 which is a cross section of an annealed 7/8-inch round bar. Here the particles are small, well broken up and uniformly distributed, indicative of correct conditions of manufacture and an ample amount of reduction in size from the ingot. This illustrates the desirable structure for high speed steel. Large rounds, for instance from 4 to 9 inches, invariably show a marked lack of uniformity in structure and the central portions frequently retain the raw ingot structure as result of insufficient reduction. The condition existing in the center of a 6-inch round is shown in Fig. 6 in contrast to the internal structural condition existing in the small bar stock where the percentage of reduction has




Figs. 13 and 14—Photomicrographs showing carbide segregation in high speed steel bar stock. Figs. 15 and 16—Photomicrographs showing structures corresponding to points *A* and *B* respectively of forged high speed steel milling cutter shown in Fig. 11. X 50. Figs. 17 and 18—Photomicrographs showing structures corresponding to points *A* and *B* respectively of high speed steel bar stock milling cutter shown in Fig. 12. X 50. Note the difference in grain structure of Figs. 15 and 16 and Figs. 17 and 18

been ample. In this condition lies the greatest advantage in the use of the forged cutter.

Little explanation is required to make clear the process of manufacture of cutters from bar stock. The material as received, which is only a small fraction of an inch over the diameter of the finished cutter is cut to the required length and the operations following are essentially milling the teeth to the required shape, hardening and grinding. Structurally the condition of the steel remains the same and it is very evident from the photographs shown that the internal condition of large high speed rounds is not desirable.

The method involved in forming a forged cutter blank is illustrated in Figs. 7 and 8. The bar stock, about one half the diameter of the desired cutter, which has previously received a large amount of reduction, is cut to the length required to furnish the necessary material after upsetting. The direction in which work has been applied, however, has been entirely longitudinal or in a direction parallel to the axis of the bar. This fact is sometimes responsible for failure of cutters made directly from bar stock especially in the larger sizes, an account of the tendency toward a grain structure which may be described as "woody" or fibrous and which is in a sense analogous to the longitudinal grain in a piece of wood. The tendency toward carbide stringers is shown in Figs. 13 and 14 which is a longitudinal section of a piece of high speed steel from bar stock ⅝-inch in diameter. Steel showing this effect tends toward planes of weakness along the lines of the segregation, which if present along the cutting edges of the tool may cause flaking off.

It is clear from Figs. 7 and 8 that after the cylinder of steel has been cut to length it is hammered and upset in a direction perpendicular to the direction in which work has previously been done. The forging is done at a temperature of approximately 2000 degrees Fahr. under a steam hammer; the disk is upset to a thickness about the size of the cutter. It is then reheated and finished in the recessing or forming dies. This procedure squeezes the metal adjacent to the outer circumference into forcible contact with the sides of the die and each blow compresses the metal heavily at the vital points. The excess metal forms a slight flash which is trimmed off later.

The extent of the refinement and compression is forcibly brought out in Figs. 11, 15 and 16. Fig. 11 is a photograph of the cross section of a forged high speed milling cutter blank in the hardened condition. It was highly polished and then etched with tincture of iodine to make the structure visible, and the photomicrographs, Figs. 15 and 16, show the structure at the points *A* and *B*.

Merely upsetting a bar into a disk or "pancake" between flat faced hammer dies does not produce the result referred to in compressing the metal heavily at the circumference, as it tends to open up the edges of the disk and the disk is very apt to split radially as shown in Fig. 10, making the structure porous at the most vital points in the cutter. This difficulty is not encountered in the drop forging process as the metal is forcibly driven into the recess of the dies and the tendency to split does not exist.

The forging process for the manufacture of cutters while more expensive from a manufacturing standpoint possesses advantages which

(*Continued on Page* 251)

# SALT BATHS FOR HEAT TREATING

By Sam Tour

## *Introduction*

*This paper is not intended to cover an extended scientific study of heat treating salts nor was the work covered by this paper such a study. It is simply a description of the work done by the writer on the subject up to the present time. The work itself is not complete and a solution of the problem of finding a salt or salts which are satisfactory for the various heat treating operations has not been found.*

## General

WHEN in heat treating work it becomes necessary to heat treat finished machine pieces of steel without scaling, oxidation, carburization, or decarburization some other method than open furnace treatment must be devised. It is true that by various means, such as keeping a reducing atmosphere in the furnace, or by use of a well sealed furnace the amount of scaling can be cut down. If however the steel being treated has been cut into complicated shapes, or is of intricate design, and especially if it has had any amount of engraving done upon it, it becomes impractical to treat it in an open furnace.

If the open furnace method is not used there remains two other methods. One is to pack-harden, pack-hardening means the packing of the pieces to be hardened in some apparenlty neutral material to protect them from oxidation. The usual material used is charcoal and cast iron chips. This pack hardening functions fairly well and when used occasionally is probably the proper method to use. In other words, if a heat treating room has only an occasional use for a hardening treatment which will not have a deleterious action on the surface it is logical and practical to use the pack hardening method. Pack hardening however, is no where near perfect in its protection against scaling, carburization and decarburization of the surface. Pack hardening is a slow and inefficient method of hardening. Large pieces with both heavy and light sections are very hard to handle in a pack hardening treatment. Removal from the packing material introduces a delay in quenching with its attendant loss of heat. A certain amount of oxidation takes place in the short interval of time that the steel is exposed to the atmosphere after removal from the furnace and before immersion in the quenching medium.

The remaining method for hardening as referred to above is with the use of molten baths. Modern methods of heating steel in the various operations of hardening and tempering demand the use of a number of different types of molten baths. Baths of molten lead have long been and still are extensively used for treating tools etc., of simple design that are properly quenched from temperatures below about 1472 degrees Fahr. If the steel being treated requires a temperature much higher than 1472 degrees Fahr. or if the piece is of such intricate design as to tend to entrap the molten lead or again if we are very particular

A paper presented before the New York Chapter. The author Sam Tour, is metallurgist, Doehler Die-Casting Co., Brooklyn, N. Y.

in regard to the surface condition of the piece after treatment the molten lead bath is not satisfactory. Baths of molten salts are becoming more and more common.

Molten salt baths can be divided into the following classes:

1—Case hardening or cyaniding baths.
2—Tempering baths for temperatures from 482 to 1022 degrees Fahr.
3—Tempering and hardening baths for temperatures from 1022 to 1517
4—Hardening bath for temperatures—1202 to 1697 degrees Fahr.
5—High speed hardening baths for temperatures up to 2372 degrees Fahr. degrees Fahr.

## Cyaniding

For case hardening or cyaniding the bath usually used is composed of a mixture of sodium cyanide NaCN, sodium chloride NaCl and sodium carbonate $Na_2CO_3$. Some prefer to start with a ternary mixture of these whereas some start with the binary NaCN and NaCl. When heated up the NaCN at the surface of the bath gradually changes over into $Na_2Co_3$. Also while kept molten some of the NaCl is lost by volatilization and some by decomposition with water in the atmosphere. The net result; and one not often realized by the use is that one may be starting with a 76 per cent NaCN 24 per cent NaCl mix and may have in his molten bath only 15 per cent NaCN 10 per cent NaCl and 75 per cent $Na_2CO_3$. The question of cyaniding bath is one worthy of an entire paper and so will not be further discussed herein.

## Tempering

For tempering baths for temperatures from 482 to 1022 degrees Fahr. mixtures of sodium nitrate $NaNO_3$ and potassium nitrate $KNO_3$ are often used as well as $NaNo_3$ and $NaNO_2$. According to curves given in Landolt and Boernstein, $NaNO_3$ melts at 586 degrees Fahr., $KNO_3$ at 642 degrees Fahr and the two at the composition of 50 molecular per cent of $KNO_3$ form a eutectic freezing at 424 degrees Fahr. Also, $NaNO_2$ melts at 543 degrees Fahr. and $NaNO_2$ and $NaNO_3$ at a concentration of 50 molecular per cent of $NaNO_2$ form a eutectic freezing at 430 degrees Fahr. Baths of these mixtures function fairly well for temperatures up to 797 degrees Fahr., but cause a certain amount of oxidation at temperatures above 797 degrees Fahr. In other words there is still to be found a salt to function satisfactorily bebetween 797 degrees Fahr. and 1022 degrees Fahr.

## Hardening

### *$CaCl_2$ and NaCl*

Tempering and hardening baths for temperatures between 1022 degrees Fahr. and 1517 degrees Fahr. are used for tempering high speed steel and for heating, for quenching carbon tool steels. A fairly satisfactory bath for this purpose, when one learns some of its idiosyncracies is a eutectic mixture of calcium chloride $CaCl_2$ and sodium chloride NaCl. $CaCl_2$ melts at approximately 1422 degrees Fahr. and NaCl at approximately 1472 degrees Fahr. whereas their eutectic mixture consisting of 72.5 per cent $CaCl_2$ by weight and 27.5 per cent NaCl freezes at 941 degrees Fahr. This salt mixture is sold to the trade by various concerns under special trade names. A new case hardening or really a

cyaniding process known as the "Shimer Process," uses a molten bath of this composition as a base and by the addition with the steel of lumps of cyanimide a cyaniding action is produced.

To make up a satisfactory salt bath of this composition it is not necessary to start with chemically pure or exceptionally high grade salt. Commercial fused calcium chloride and commercial table salt answer the purpose very nicely. The mixture will not function properly however when first made up. It is necessary to heat it up to around 1652 degrees Fahr. several times before it is possible to use it for steel treating purposes and have the steel come out with a clean bright surface. When first made up this mixture has a decided pitting action on steel. After heating a number of times it has been found that this pitting action gradually diminishes and that after heating and cooling about four times the action has entirely ceased. From this point on, this non pitting mixture is satisfactory in many ways for the heat treating of steel but it has its serious disadvantages. Calcium chloride, which constitutes the bulk of this salt mixture, is very hygroscopic and also is a rust promoter. The operation of the bath results in a certain amount of fuming. These fumes carry and deposit calcium chloride into every part of the building and there the calcium chloride attracts moisture and immediately rapid rusting and corrosion sets in. In addition to this disadvantage the use of a bath containing any calcium chloride requires that the steel after quenching be carefully scrubbed and washed to remove the last traces of salt before it is tempered in order that corrosion and pitting of the surface be avoided. The use of a hot sal soda solution or some one of the standard cleaning compounds for this washing has been found quite satisfactory. The sal soda changes the remaining traces of $CaCl_2$ to the carbonate form which is not a very active rust promoter. Some of the standard cleaning solutions may be somewhat better than the straight sal soda solution in that they not only have an action similar to that of sal soda but they leave a slight deposit on the steel which assists in preventing further rusting.

In was found that this $CaCl_2$ and NaCl mixture could not be made to function properly when made up in a clay or graphite pot. At first it was thought possible that the pitting action which occured was not due to the presence of the clay but due to the absence of iron which might be necessary to combine with and remove impurities present in the salt bath. If this were true, then the addition of cast iron chips should have eliminated this difficulty but on trial this was found not to be the case. Mr. H. V. Thompson, *Transactions* of the English Ceramics Society Vol. 17, 1918, in studying the dissociation of salt found that fused NaCl and the moisture of the atmosphere reacted with $SiO_2$, $Fe_2O_3$, $Al_2O_3$ and clays. Some reaction of this nature no doubt is the explanation of the difficulties encountered with these two salts when attempts are made to use them in clay or graphite crucibles. These salts work satisfactorily in iron, steel or alloy steel pots.

In passing, a certain peculiar characteristics of this salt mixture on cooling seems to be worth mentioning. Just after the molten salt has solidified and is at a temperature around 932 degrees Fahr. it is very dark grey, almost black in color. As this salt cools however it gradually becomes lighter in color until around 257 degrees Fahr. it

is of a light grey color and in the form of a solid rather strong columnar crystalline mass. At about 212 degrees Fahr. however the salt suddenly changes from this light grey color to white. This change is accompanied by an expansion which causes the previously solid chunks of salt to break up and crumble into small pieces. These changes are probably the external evidence of the breaking down of a double salt of calcium and sodium which forms in the molten bath but which is not stable at room temperatures. The exact nature of these changes are probably not of any importance insofar as heat treatment of steel is concerned.

### *$CaCl_2$-NaCl-KCl*

The ternary mixture of potassium sodium and calcium chlorides has been studied by several investigators. A eutectic mixture of these salts consists of 50 per cent KCl, 30 per cent $CaCl_2$ and 20 per cent NaCl and freezes at about 986 degrees Fahr. This mixture presents a case similar to the $CaCl_2$ and NaCl mixture in regard to pitting action. It is a little easier to wash off after quenching but its loss by volatilization is considerably greater and is in such proportions as to destroy the eutectic nature of the entire mix. Insofar as $CaCl_2$ content is concerned it presents the same disadvantages, although not so accentuated as does the straight $CaCl_2$ and NaCl mixture. With respect to disagreeable fumes and pot life it is inferior to the $CaCl_2$ and NaCl mixture.

Another eutectic mixture of these three salts as found by C. A. H. Lantsberry, Journal of the Society of Chemical Industry Vol. 39 1920. is composed of 70 per cent $CaCl_2$, 25 per cent NaCl and 5 per cent KCl which freezes at approximately 932 degrees Fahr. Thus no real advantage is gained by the addition of the more expensive KCl to a mixture of $CaCl_2$ and NaCl.

Considerable work has been done on this ternary system by various investigators. The most notable papers appearing in the literature are those by Menge and by Lamplough. (Menge, Z. *Anorg. Chem.*, 1911, 9,162.) (Lamplough, *Próc.* Camb Phil. Soc., 1911, 103-196.)

### *$BaCl_2$ and NaCl*

A binary mixture of barium chloride $BaCl_2$ and sodium chloride NaCl has been much used as a salt for heat treating purposes. This mixture being free from $CaCl_2$ is free from the disadvantages of being hygroscopic, and of being a strong rust promoter. According to various authorities $BaCl_2$ melts at from 1580 to 1760 degrees Fahr. According to Le Chatelier a eutectic mixture consisting of 22.25 per cent by weight of NaCl and the balance $BaCl_2$ freezes at 1175 degrees Fahr. The disadvantages of this salt are its rather high melting point, the difficulty in cleaning the surface of the steel after quenching in oil, and the tendency of the salt film on the steel to act as an insulator and cause a localized decrease in effect of quenching and to cause soft spots. This salt also has a tendency to pit the surface of the steel after the bath has been run for a few days. On one or two occasions it was found that the addition of a small amount of NaOH retarded this action.

### *$BaCl_2$ and $CaCl_2$*

A mixture of $BaCl_2$ and $CaCl_2$, according to Ruff and Plato in Landolt & Boernstein containing 35 molecular per cent of $BaCl_2$ (approxi-

mately 45 per cent $BaCl_2$ by weight) freezes at 1112 degrees Fahr. In our tests we found this mixture to freeze at 1030 degrees Fahr. The only explanation we can find for this is that some of the previous mixtures tried (a NaCl-$Na_2CO_3$ mixture) might have remained in the pot and have thus lowered the freezing point.

At about 1148 degrees Fahr. this salt takes on a blackish color which becomes more intense as it nears the freezing point. The frozen salt has a dark slate color. Due to the large amount of $CaCl_2$ in this mixture it is very hygroscopic and picks up a large amount of water over night.

As regards lack of pitting action and its cleaning off properties this salt leaves little to be desired. On the very first melting a piece of alloy steel cleaned off perfectly and showed no pitting. In this respect this mixture is as good as any we have found but the large amount of $CaCl_2$ in it prohibits its use. This is unfortunate as it is acceptable in other respects, especially on account of its very low freezing point.

### *$BaCl_2$-KCl-NaCl*

A ternary mixture of $BaCl_2$, KCl and NaCl, has been studied also. E. Vortich—The system $BaCl_2$ KCl and NaCl, Neuen Jahrbuch F. Min. etc. Beil. Bd. 38 p 513., found a eutectic mixture of these salts freezing at 1010 degrees Fahr., with the composition 28 molecular per cent $BaCl_2$, 39 molecular per cent KCl and 33 molecular per cent of NaCl. H. Gemsky, Neuen Jahrbuch F. Min. etc. Beil. Bd. 36 p. 513 found a eutectic freezing at practically the same temperature but gives the composition as 24 molecular per cent $BaCl_2$, 39.5 molecular per cent of KCl and 36.5 molecular per cent of NaCl. This same system has also been studied and discussed by Ernst Janecke, Hanover, *Centralblatt Min. Geol.* 1919 pages 271-4. This system has also been reviewed theoretically by Liebisch, Zeit. Anorg and Allgem. Chemie. 99, 50-66, (1917). None of the work referred to above was along the line of a practical application of this mixture as a salt bath for heat treating purposes. The writer made up a mixture of salts approximating the composition given above and consisting of 50 per cent $BaCl_2$ by weight, 30 per cent $CaCl_2$ and 20 per cent NaCl, and found that this salt mixture pitted when first made up and was cleaned off only with great difficulty after only the first trial. After heating it up the third time it has ceased to pit and cleaned off more easily but still not easy enough. Even after reheating five times it failed to develop good cleaning properties. It was also found that the salt fumed quite profusely when at temperatures around 1652 degrees Fahr. The addition of ½ per cent of NaOH to the mixture did not seem to have any effect on its cleaning, pitting or fuming properties. The excessive fuming and the difficulty in cleaning makes this an unsatisfactory heat treating salt.

### *NaCl and KCl*

The binary system NaCl and KCl forms a eutectic at a composition of 50 molecular per cent of KCl, which freezes at 664 degrees Cent. 1227 degrees Fahr). This excessively high minimum temperature and the excessive fuming of the molten bath at temperatures around 850

degrees Cent. (1562 degrees Fahr.) makes this mixture an unsatisfactory one for use in the heat treating room.

### *$Na_2SO_4$ and NaCl*

The binary system sodium sulphate $Na_2SO_4$-NaCl forms a eutectic, a composition of 46 molecular per cent of $Na_2SO_4$ which freezes at 1155 degrees Fahr. Two attempts were made to try this mixture but on each occasion the salt fused its way through the one inch thick cast iron pot being used, before the total salt mixture was entirely molten. In other words, this salt mixture reacts with iron so readily that it is out of the question as a heat treating salt bath material.

### *$Na_2CO_3$ and NaCl*

According to Le Chatelier, Landolt and Boernstein Physical Tables, the binary system sodium carbonate $Na_2Co_3$ and NaCl forms a eutectic at a composition of 34.7 per cent by weight of NaCl with a freezing point of 1148 degrees Fahr. However, a hard solid crust forms on the surface at 1202 degrees Fahr. so that the salt cannot be used below that temperature. This mixture does not pit but forms a coating of black, carbonaceous material resembling lamp-black, which cannot be removed from the surface even with emery. Repeating heating does not improve the salt.

## Conclusion

A number of different combinations of salts are used and recommended by various people, but each has some vital defect or objectionable quality. Most of these combinations are eutectic mixtures of metallic chlorides, such as calcium chloride, barium chloride, sodium chloride and potassium chloride.

Calcium Chloride is hygroscopic, must be carefully washed off the steel, or will cause corrosion, and has a tendency to pit. Calcium chloride alone has a melting point around 1420 degrees Fahr. which is too high for use.

Barium Chloride alone has a melting point variously stated from 1580 to 1760 degrees Fahr. which is too high for use except for high speed steel. It is claimed that barium chloride develops a pitting action after it has been in use a few days at temperatures around 2012 degrees Fahr. and almost immediately at temperatures around 2372 degrees Fahr. Some authorities say, but this has not been found true by the writer, that the addition of a small amount of NaOH every few days keeps down this pitting action.

Sodium Chloride melts around 1472 degrees Fahr. and appears to be rather inert as far as corrosive and pitting action is concerned, except at the surface in contact with air. The original impurities however in sodium chloride such as magnesium salts, sulphates, etc., might be the source of the trouble which has occasionally been found with fused sodium chloride. The melting point of sodium chloride is too high however for it to be used alone.

Potassium Chloride melts at around 1438 degrees Fahr. and has the same objectionable features as sodium chloride, and in addition it

has greater volatilization. Fumes of any of these salts are of course objectionable although those of calcium chloride are the most objectionable.

SODIUM CARBONATE melts at around 1508 degrees Fahr. and thus has too high a melting point to be used alone. There is some question as to its decarburizing effect when used at high temperatures on high carbon steel especially.

POTASSIUM CARBONATE melts at around 1652 degrees Fahr. and is open to the same objections as sodium carbonate.

Some eutectic mixture of two or more of the above salts will no doubt be the best solution of the problem.

A proper salt bath for the heat treating of complicated parts of high grade steel other than high speed steel should meet the following requirements:—

1. *It should have no corrosive or pitting action upon the steel.*
2. *It should have neither a carburizing nor de-carburizing action on the steel.*
3. *It should melt at some temperature below* 1020 *degrees Fahr.*
4. *It should not give off objectionable fumes at* 1700 *degrees Fahr.*
5. *It should not attack the cast iron or alloy pot used for heating.*
6. *It should not deposit a sludge in the bottom of the pot.*
7. *It should leave only a thin film of molten salt adhering to the piece of steel as the piece is lowered into the quenching bath.*
8. *The salt and oil mixtures on the steel after quenching should be easily removable, by rubbing with waste.*
9. *The salts should be such that no harm would be done if the steel is tempered while some of the salts still remain upon it.*
10. *The salts should be non-hygroscopic.*
11. *The salts should have no rust promoting action.*

The reason for most of the above requirements are quite obvious. The ideal salt bath would be one which gave no pitting action, which gave the maximum life of pot, and which would not require careful washing of the piece of steel after quenching. Such an ideal salt has as yet not been found so far as the writer is aware.

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## Advantages of the Forged Milling Cutter

(*Continued from Page* 244)

cannot be overlooked by the user of milling cutters and the fact alone that the largest users are now beginning to specify forged cutters is sufficient evidence that the claims of increased performance made for the forged cutter are being realized.

# The Question Box

**A Column Devoted to the Asking, Answering and Discussing of Practical Questions in Heat Treatment—Members Submitting Answers and Discussions Are Requested to Refer to Serial Numbers of Questions.**

## NEW QUESTIONS

*QUESTION* 51. *What are the causes of black fractures in high carbon tool steel?*

*QUESTION* 52. *Is the Brinell hardness number of a given piece of steel, an accurate measure of its machinability?*

*QUESTION* 53. *What is the composition of the so-called semi-steel?*

*QUESTION* 54. *Is it possible for a piece of commercially pure iron in contact with a piece of high carbon steel, to absorb carbon from the steel?*

*QUESTION* 55. *What are the causes of soft spots in the carburizing of steel?*

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## ANSWERS TO OLD QUESTIONS

*QUESTION NO. 27. What is the function of the high phosphorus and the high sulphur content in the so called automatic screw stock steel?*

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*QUESTION NO.* 30 *How do the physical properties of a chrome molybdenum steel vary from the physical properties of a chrome vanadium steel after suitable heat treatments have been given to each?*

ANSWER. By J. S. Vanick, metallurgist, U. S. Bureau of Standards, Washington, D. C.

An immediate difficulty in answer to this question, lies in defining, what is ment, in terms of composition, by a chrome-molybdenum steel. The chrome-vanadium steels are not hampered by this difficulty.

A comparison of the mechanical properties, viz., strength, ductility and hardness of the usual chrome-vanadium steel of the .30 C type, may be made from the data presented by Hoyt (1) French, (2) and Sargent (3), (4). These data show, for oil-quenched steels, an advantage in strength in favor of the chrome-vanadium steel.

Water quenching the chrome-molybdenum steel, brings up the strength, which, however, remains below the oil-hardened, chrome-vanadium maximum, indicating that the strength possibilities of chrome-vanadium steels are superior to those of chrome-molybdenum steels. High ductility values, reported by Sargent, are not confirmed by French. The high ductility of chrome-

molybdenum steels approaches the lower values for chrome-vanadium steels when the corresponding tensile values are more nearly equal.

Hardness values for the two steels are quite similar when equivalent values for strength and ductility prevail.

Data Sheet

Steel Compositions

| | I | II | III | IV | V |
|---|---|---|---|---|---|
| C | .32 | .32 | .27 | .39* | .30 |
| Mn | .55 | .55 | 1.01* | .76 | .60 |
| Cr | .90 | .90 | .88 | 1.07 | 1.0 |
| Mo | .37 | .37 | .52 | .... | .... |
| V | ... | ... | .... | .21 | .18 |

* High content

| | | | | | |
|---|---|---|---|---|---|
| Heat Treatment | I | Quenched in oil from 1700° F. | Tempered as shown | | |
| | II | " in water from 1600° F. | " | " | " |
| | III | " in oil from 1550° F. | " | " | " |
| | IV | " in oil from 1600° F. | " | " | " |
| | V | " in oil from 1650° F. | " | " | " |

Tensile Strength

| Tempered ° F | I | II | III | IV | V |
|---|---|---|---|---|---|
| none | ..... | ..... | 181,000 | ..... | 214,000 |
| 200 | ..... | ..... | ..... | ..... | ..... |
| 400 | 143,000* | 230,000 | 187,000 | 250,000 | 245,000 |
| 600 | 143,000* | 220,000 | ..... | 230,000 | 236,000 |
| 800 | 143,000 | 210,000 | 176,000 | 200,000 | 211,000 |
| 1000 | 135,000 | 190,000 | ..... | 170,000 | 163,000 |
| 1200 | 122,000 | 150,000 | 125,000 | 130,000 | 149,000 |

Elastic Limit (method, not indicated)

| | | | | | |
|---|---|---|---|---|---|
| 400 | 135,000* | 205,000* | ..... | 215,000 | 230,000 |
| 600 | 135,000* | 205,000* | ..... | 205,000 | 227,000 |
| 800 | 130,000 | 195,000 | ..... | 185,000 | 180,000 |
| 1000 | 125,000 | 175,000 | ..... | 150,000 | 142,000 |
| 1200 | 110,000 | 140,000 | ..... | 110,000 | 130,000 |

Elongation in 2 in.

| | | | | | |
|---|---|---|---|---|---|
| none | | | 4.0 | | 1.0 |
| 400 | 15.0* | 11.0 | 6.8 | 8.0 | 6.0 |
| 600 | 15.0* | 11.0 | .... | 10.0 | 8.0 |
| 800 | 16.0 | 12.0 | 10.0 | 13.0 | 11.0 |
| 1000 | 17.0 | 15.0 | .... | 17.0 | 16.0 |
| 1200 | 21.0 | 20.0 | 20.8 | 21.0 | 18.0 |

Reduction of Area

| | | | | | |
|---|---|---|---|---|---|
| none | | | 5.9 | | 6 |
| 400 | 56* | 46 | 10.2 | 17 | 20 |
| 600 | 57* | 48 | .... | 22 | 43 |
| 800 | 58 | 51 | 36.6 | 33 | 48 |
| 1000 | 60 | 56 | .... | 44.0 | 53 |
| 1200 | 64 | 63 | 63.0 | 54 | 60 |

Approximate

Differences in the compositions of the chrome-molybdenum steels above, particularly in C, Mn and Mo, prevent better comparisons with equivalent vanadium steels. More comprehensive studies of molybdenum steels are necessary to better determine the effect of the element.

(1) Hoyt, S. L. Metallography, Part II, The Metals and Common Alloys, Table 122, p. 429.

(2) French, H. J. Trans. A. S. S. T. June, 1922, p. 788, Table XII.

(3) Sargent, G. W. Trans. A. S. T. M 1920, vol. 20, Fig. 2, p. 12.

(4) Climax Molybdenum Co., Catalog, Molybdenum Commercial Steels, p. 35.

*QUESTION NO. 35. What is the difference between red annealed and blue annealed sheet steel?*

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*QUESTION NO. 38. What regulations are recommended to reduce the fire hazzard of quenching tanks?*

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*QUESTION 41. Is the X-ray examination of steels commercially practicable?*

ANSWER. A considerable amount of research and laboratory work has been done on the X-ray examination of metals and there are many factors which effect this method of examination of metals. Many rearrangements and re-design of equipment have been necessary in order that the operator could get satisfactory results. It is assumed that the author of this question refers to the examination of metals by means of X-ray, to determine whether or not there are any blow holes, or pipes within the metal. In Volume 1 of the Journal of the American Steel Treaters' Society, Sir Robert Hadfield discusses the subject of radiometallography in which he reproduces X-ray photographs of metal castings showing blow holes and inclusions in the castings. The article states that the present application of X-ray photography makes it possible to use only comparatively thin specimens of metal, while the usual type of castings which are desired for inspection are of considerable size. So far, the information which is available on the subject of X-ray examinations of metals indicates that this method of examination is not commercially practicable, however, it is entirely feasible that such a method will be developed as a commercial method of inspection.

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*QUESTION 44. Is it advantageous for the purchaser to conduct a test on various brands of high speed steel before deciding upon placing his contract?*

ANSWER. The only true test for a brand of high-speed steel is the service that it gives by continued performance month in and month out under actual shop conditions. The average buyer of high-speed steel is not justified in conducting a test, but can well continue to purchase his requirements of high-speed steel from a reputable manufacturer of a brand that is nationally known. The manufacturer of high-speed steel is always willing to co-operate with the trade in the conducting of a test and is much interested in the information received from a well conducted test. A test of high-speed steel, to be valuable, should be conducted in a manner as nearly approaching actual working conditions in the plant in which the test is made, as is practical. In conducting a test a few reputable brands of high-speed steel should be allowed to enter. The test should be conducted along lines laid down by customer and all competitors should be treated equally. All tools entered should be of exactly the same size and shape. There is much difference of opinion as to the best practical method of conducting a test, and the decision as to how the test should be conducted should be left to the customer, who should co-operate with the manufacturers in devising a test which would give the best basis for conclusions as to how the particular brands of high speed-steel would perform under actual shop conditions.

*QUESTION* 46. *Is the practice of buying high-speed steel by brand names instead of physical, chemical and metallurgical specifications justifiable?*

ANSWER. The practice of buying high speed steel by brand names is justifiable. The guarantee behind high speed steel is the standing and reputation of the manufacturer, who should maintain in his employ metallurgists and experienced service men who will defend the quality of his product and be ready at any time to heat-treat and demonstrate to buyer's satisfaction that the product furnished by him will meet any of his reasonable requirements. The customer's specifying the chemical, physical or metallurgical properties relieves the manufacturer of his responsibility as to quality. Quality is not dependent upon the chemical composition and poor high speed steel can be made within any limits of chemical contents that could be commercially met by a manufacturer of best quality high speed steel. In purchasing high speed steel by brand name the buyer places responsibility for performance clearly with the manufacturer. The specifying of physical, chemical or metallurgical limits by buyer would lead to endless controversy and would positively retard, in fact, completely arrest the progress of the industry.

The manufacturers of high speed steel should co-operate with the user to the extent of submitting upon request rejection limits as to chemical content of those elements which vitally affect the steel treater's work. It is not desirable that the manufacturer's rejection limits be published broadcast. The buyer has the right to demand that high speed steel purchased by him should be within the generally accepted analysis of high speed steel. Chemical composition is a basic consideration, but the quality is dependent upon many other factors, the most important of which is the human element. No steel treater can question the fact that the results obtained from heat-treating depend upon the operator. The operator will use all modern appliances, such as pyrometer, automatic temperature control, quenching machines, etc., but the results obtained depend upon his individual experience and skill. The manufacture of tool steel is and will continue to be a handicraft industry.

Modern tool steel practice has changed from that of the past, not by the use of labor-saving machinery, but by the use of scientific devices which aid and guide the skilled craftsman in producing a steel of higher quality and greater uniformity. It is upon the intelligence, experience and skill of the individual that quality of tool steel depends.

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*QUESTION* 47. *What is meant by "secondary hardness" in the tempering of high-speed steel.*

ANSWER. The term "secondary hardness" has been applied to the increase in hardness of a piece of high-speed steel, over the original hardness resulting from quenching the specimen from a high temperature, when it is tempered at a temperature in the neighborhood of 600 degrees Cent.

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*QUESTION* 48. *What are dendrites and how may they be detected?*

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*QUESTION* 49. *Can dendrites be removed through a proper heat treatment?*

(*Continued on Page* 271)

# Abstracts of Technical Articles

**Brief Reviews of Publications of Interest to Metallurgists and Steel Treaters**

TREATING HIGH SPEED TOOL STEEL. By H. K. Ogilvie in *Iron Trade Review,* October 26, 1922. Reprinted from a paper presented at the meeting of the Iron and Steel Institute at York, England, Sept. 5-6.

This paper discusses the process of manufacture of high speed steel, including the crucible method and the basic lined electric furnace method which is usually used for making tungsten steel for lathe turning tools, cutters and drills.

The various types of ingot molds and the method of pouring, temperatures, etc., are discussed. Fractures and microscopic structures resulting from varied heat treatments, together with hardness tests, are discussed.

OVERSTRAIN, INTERNAL STRESSES AND CREEP. By Zay Jerries and R. S. Archer, in *Chemical and Metallurgical Engineering,* Vol. 27, No. 17, Oct. 25, 1922.

The authors liken the effects of working hot-rolled iron or mild steel at blue heat to similar conditions observed in nickel and certain alloys. These phenomena and the results of overstrain are all due to rapid acquisition of increased strength on slip planes.

SHRINKAGE AND EXPANSION OF HIGH-SPEED STEEL DUE TO HEAT-TREATMENT. By M. A. Grossmann, in *Chemical and Metallurgical Engineering.* Vol. 27, No. 11. September, 1922.

The author describes tests which were recently undertaken to obtain data on the amount which should be allowed in high-speed tools for shrinkage or expansion resulting from heat treatment. Volume and hardness changes, thermal analysis and microscopic structure indicate that secondary hardness in high-speed steel is due to the decomposition of stable austenite into martensite which is different from martensite formed during quenching.

MECHANICAL PROPERTIES AS AFFECTED BY GRAIN SIZE. By Zay Jeffries and R. S. Archer. In *Chemical and Metallurgical Engineering.* Vol. 27, No. 16. October, 1922.

This paper discusses the reasons that variation in the average size of crystalline grains comprising the metal may be expected to influence the mechanical properites of the aggregate. Grain boundaries add a certain stiffness to a metallic aggregate. Fine grain size generally involves higher tensile strength and hardness with greater reduction of area. Maximum elongation requires medium grain size.

INVAR, ELINVAR AND OTHER NICKEL STEELS. By W. D. Williams. In *Raw Material.* Vol. V, No. 9. October, 1922.

The author discusses quite fully the history of nickel steels, especially of the invar type, including electrical properties, thermal critical points and mechanical properties. This is the first of a series of articles dealing with nickel steels.

MECHANICAL PROPERTIES OF COMMERCIAL IRON. By Zay Jeffries and R. S. Archer. In *Chemical and Metallurgical Engineering.* Vol. 27, No. 14. October, 1922.

This paper discusses the definitions of various terms used in the art of testing materials, and a discussion of how various circumstances surrounding the test affect the results on annealed bars of common structural metals.

ADSORPTION A CRITERION OF CORROSION. By D. D. Saklatwalla. In *Chemical and Metallurgical Engineering.* Vol. 27, No. 13. September, 1922.

Various theories on subject briefly discussed.

GRAPHITIZATION IN A CARBON TOOL STEEL. By H. S. Rawdon and S. Epstein. In *Chemical and Metallurgical Engineering*. Vol. 27, No. 13. September, 1922.

The work covered in this article is in connection with a paper on the same subject by A. W. F. Green. The authors worked upon a specimen submitted by Mr. Green and found no expalanation of the peculiar behavior of the material.

EFFECT OF TEMPERATURE, PRESSURE AND STRUCTURE ON MECHANICAL PROPERTIES OF METAL. By Zay Jeffries and R. S. Archer. In *Chemical and Metallurgical Engineering*. Vol. 27, No. 15. October, 1922.

This paper deals with effect of temperature on the crystal structure of a metal which in turn affects the mechanical properties of the aggregate. It is found that recrystallization, annealing, cold work and foreign inclusions have a profound effect on the size and the shape of crystalline grains and therefore on the mechanical properties. The discussion includes a study of the mechanical properties of a single crystal.

RECENT DEVELOPMENTS IN FATIGUE OF METALS. By H. F. Moore and T. M. Jasper. In *Iron Age*. Vol. 110, No. 13. September, 1922.

The authors describe the latest type of fatigue testing machine used in their laboratory at the University of Illinois. The effects of heat treatment are discussed as affecting the fatigue resisting properties of metals. Several charts are presented showing the various mechanical properties of the steels tested compared to fatigue strength.

ALLOY CASTINGS FROM ELECTRIC FURNACES. By L. J. Barton. In *Iron Age*. Vol. 110, No. 13. September, 1922.

Among some of the newer lines of metallurgical endeavor is the manufacture of alloy steel castings to be heat-treated and used as a substitute for forgings and for purposes where ordinary grades of steel castings will not stand up under the duty imposed. The author discusses nickel, chromium and chrome-nickel steel made on the Pacific coast, including their production properties and heat treatment.

PEARLITIC AND SORBITIC MANGANESE STEELS. By J. H. Hall. In *Iron Age*. Vol. 110, No. 13. September, 1922.

This article makes a plea for castings containing about one per cent manganese instead of the lower contents. The author reviews some of the literature on the subject and discusses the heat treatment of steels containing varying contents of manganese.

INFLUENCE OF MASS IN HEAT TREATMENT. By E. J. Janitzky. In *Iron Age*. Vol. 110, No. 13. September, 1922.

This paper discusses the role of special elements such as nickel, chromium and molybdenum in counteracting the effect of size. Experimental data is given on sections 0.5 to 3 inches in diameter.

TREND OF SPECIFICATIONS FOR STEEL CASTINGS. By E. R. Young. In *Blast Furnace and Steel Plant*. September, 1922. Page 463.

This article involves a general discussion covering the important features of steel castings specifications such as chemical composition, physical properties and some of the newer methods of testing.

ACID-RESISTING METALS AND ALLOYS. By G. A. Drysdale. *Mechanical Engineering*. Vol. 44, No. 9. September, 1922. Page 579.

An account of research work carried out on various non-ferrous metals and alloys, with especial reference to their use in the manufacture of mine pumps and chemical apparatus.

# Comment and Discussion

**Papers and Articles Presented Before the Society and Published in Transactions Are Open to Comment and Criticism in This Column—Members Submitting Discussions Are Requested to Give Their Names and Addresses**

A COMMUNICATION recently received from Mr. Arthur G. Henry, of the Vanadium Alloys Steel Co. contained the following historical sketch of the Bessemer Process. Mr. Henry spent some of his early years at the Ebbw Vale Iron Works:

## The Bessemer Process—Historical

The story of the early struggles, defeats, and successes in developing the Bessemer Process of making steel has all the fascination of a romance. Sir Henry Bessmer, in an autograph letter which was presented to the American Institute of Mining Engineers by the then Sir James Kitson, Bart., has given a graphic account of what led to the experiments which ultimately brought him so much well-earned renown. While engaged with projectile trials in the fortress at Vincennes, an officer made a casual remark about superior material for guns, which arrested Bessemer's attention. "This casual observation," says Sir Henry, "was the spark that kindled one of the greatest industrial revolutions that the present century has to record, for, during my solitary ride in a cab that night from Vincennes to Paris, I made up my mind to try what I could do to improve the quality of iron used in the manufacture of guns."

It was at the Cheltenham meeting of the British Association on August 11, 1856, that Sir Henry Bessemer made known to the world his process. Licenses were in great demand. The idea of converting iron into steel in a few minutes without the aid of external fuel was startling, and aroused the curiosity of manufacturers of wrought iron. But the imperfect knowledge of the chemical reactions in the process and the influence of the volume and pressure of air, as well as a wrong conception that any class of pig iron could be used in the process, contributed to a rapid reversal of opinion regarding the merits of the discovery.

Other investigations in this country and abroad had been working toward the same object. The interest aroused by the patent of Joseph Gillott Martien, of Newark, New Jersey, U. S. A., dated Sept. 15, 1855, and the experiment of Mr. George Parry, of the Ebbw Vale Iron works, in October or November, 1855, have long since been forgotten. Dr. Percy, in referring to Mr. Parry's experiment, says that "if an accident had not unfortunately occurred, Bessemer might have been shorn of his glory."

On January 10, 1857, William Kelly obtained his first American patent, and claimed, says, Mr. R. W. Hunt, "priority in the discovery of the principles of the process, and the Patent Office allowed his claim by granting his patents." Bessemer had, however, obtained patents for his process in America dated February 12, 1856, and August 25 of the same year, and while the Kelly Pneumatic Process Co., which was formed in 1863, and finally abandoned in 1869, was allowed to operate the patents of Kelly, and was

the first to make Bessemer steel in America at the works at Wyandotte, in the fall of 1864, under the direction of Mr. W. F. Durfee, it has long since been admitted that the inner and governing principle of the great discovery emanated from the brain of the genius Henry Bessemer.

The pioneer of the Bessemer process in America, and one to whom all steel men would readily award the honor of having very largely contributed to its development and success, was Mr. Alexander M. Holley. It was he who negotiated with Bessemer the American patent rights for the Winslow, Griswold, and Holley Co., and started, in February, 1865, the first 2½-ton converter at Troy, New York, thus inaugurating the Bessemer steel production of America, which, during the year 1911, amounted to 7,947,849 tons. Mr. Robert W. Hunt, in his presidential address in 1906 to the American Institution of Mining Engineers, said, in referring to American Bessemer practice, "that the names of Holley, John Fritz, George Fritz, William R. Jones, Daniel L. Jones, and Robert Forsyth furnish a galaxy of talent which makes plain why America so soon forged to the front in Bessemer steel production."

Going backwards to the introduction of the process in this country, perhaps the most eventful years in the early history of the process were the first two, during which Bessemer had cause to reflect that he had too readily granted licenses for a process the full significance of which was not at first realized by himself. While he was struggling to perfect his process, others were experimenting with the same object. James Riley tells of a crude experiment made in 1857 at the Coats Iron Works, Scotland, by Mr. Thomas Jackson, and afterwards of experiments at the works of William Dixon, Ltd., all of which were unsatisfactory. To Robert Mushet, in this country, and to F. Goransson, in Sweden, the Commercial success of the process is largely due. Professor Akermann, referring to Goransson's early experiments with the Bessemer process at the Edske blast furnace works in 1857, says that, "until the middle of 1858, he, like Sir Henry himself, had succeeded only exceptionally in turning out a good product while following the advice of the inventor to lay the greatest weight on having a high pressure of blast By departing from that advice, by means of larger tuyere area and an abundant supply of blast, Goransson was able, beginning with July 18th, 1858, so to shorten the time necessary for the process, and thereby increase the heat of the blow, that an improved product was obtained; and from that day forth the success of the Bessemer process was first assured." Professor Akermann also tells how Goransson sent 15 tons of ingot to Sheffield, made by his improved method, while Bessemer was still struggling to make good steel.

It would appear that the improvement made by Goransson impressed Bessemer, who for two years after the Edske trials, used Swedish pig iron only in his converter at Sheffield.

# News of the Chapters

## SCHEDULED REGULAR MEETING NIGHTS

FOR the convenience of visiting members, those chapters having regular meeting nights are listed below. It is desired that all secretaries whose chapters are not included in the list should communicate with the National Office in order that the list may be as complete as possible.

Boston—Second Tuesday
Bridgeport—Thursday between 20th and end of month
Chicago—Second Thursday
Cincinnati—Second Thursday
Cleveland—Fourth Friday, Cleveland Engineering Society Rooms, Hotel Winton; meeting at 8:00 p. m.
Detroit—Second and fourth Monday. For meeting place call W. G. Calkins, Sec'y. Detroit Twist Drill Co.
Hartford—Friday nearest 10th of month
Indianapolis—Second Monday
Lehigh Valley—No regular night
New York—Third Wednesday
Philadelphia—Last Friday
Pittsburgh—First Tuesday
Providence—No regular night. Nov. 10th, Dec. 12th.
Schenectady—Third Tuesday
Springfield—Third Friday
South Bend—Second Wednesday
Syracuse—No regular night
Tri City—Thursday
Washington—Third Friday

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## STANDING OF THE CHAPTERS

There were but 45 new members received during the month. Of this number Detroit received 20, Milwaukee 6, Pittsburgh and Philadelphia 4 each, while the others were scattering.

The standing is as follows. Those printed in CAPS have advanced their positions. Those underlined have lowered their positions.

1. Chicago
2. Detroit
3. Pittsburgh
4. Philadelphia
5. Cleveland
6. New York
7. Hartford
8. Milwaukee
9. Boston
10. Lehigh Valley
11. Indianapolis
12. ROCKKFORD
13. *Syracuse*
14. Worcester
15. Cincinnati
16. Washington
17. North West
18. Springfield
19. *Tri City
20. *Providence
21. New Haven
22. Buffalo
23. Schenectady
24. St. Louis
25. Toronto
26. South Bend
27. Rochester
28. Bridgeport

*=Tied

The following comments are self-explanatory.

TO CHICAGO (1), and DETROIT (2).

According to the standing on October 1st Detroit was 27 members behind Chicago, however this number has been more than made up at the present time due to the large number of members secured by Detroit at the Convention, as well as the large number of new applications turned in. While the re-report on Nov. 1st will see position Number 1 taken by Detroit.

TO CLEVELAND (5) and NEW YORK (6).

The tie existing between Cleveland and New York has been broken, Cleveland having the advantage of one member.

TO MILWAUKEE (8) and HARTFORD (7).

Milwauke is deserving of special commendation because of the rapid and successful climb it has had during the past few months. All appreciate its efforts to pass Hartford in No. 7 and there is at the present time but one membership separating Milwaukee from the coveted 7th position.

TO SYRACUSE (13), ROCKFORD (12).

The tie between these two chapters last month has been broken in favor of Rockford which has one member more than Syracuse and consequently is in 12th position while Syracuse assumes place No. 11.

TO TRI CITY (19) and PROVIDENCE (20).

The tie existing between these two cities continued during the past month, neither chapter having shown a gain or less.

The relative position of the other chapters is practically the same as on the last report.

## MEMBERSHIP CONTEST

At the delegates' meeting in Detroit a resolution was proposed and favorably acted upon that the Board of Directors of the A. S. S. T. should be requested to inaugurate a membership contest among the various chapters and offer suitable prizes to the chapters showing the largest increase in membership during a certain period.

The Board of Directors took the matter under consideration and appointed a committee to investigate the matter and make a report at the regular meeting in Cleveland on Oct. 27, 1922. This report was made to and approved by the Board and we are communicating this report to you as well as the rules governing the contest.

You will observe that the contest provides prizes not only for the increase of chapter membership but also chapter attendance at meetings. The reason for the inclusion of this feature is given in the report of the committee.

The report of the committee and rules for the contests, which begin on the dates mentioned, are as follows:

### Report of the Special Committee on Cash Prize for Percentage Increase of Chapter Membership and Chapter Attendance

The special committee appointed at the meeting of the Board of Directors on October 6, 1922, to investigate the request of the Chapter delegates that a cash prize be awarded for percentage of net increase in membership in the local chapters, as well as the question of increase in attendance at local chapter meetings, beg leave to submit the following report:

The Committee has considered the action of the delegates at their session

held in connection with the recent Convention on October 3, 1922. It has also been moved by the thoughts expressed by many members of the Society that mere increase in membership should not be the sole aim of our organization. It believes rather that the continued interest of a stable membership with a sound and healthy growth will best promote the aims of the Society.

It has, therefore, recommended that combination prizes be given to the local chapters for percentage of net increases in membership and percentage attendance of members at the meetings of the local chapters. It is the committee's idea that one is quite as important as the other, and for that reason they each should count 50 per cent toward the prizes.

At the delegates' session the sum of $300.00 was recommended as the amount to be devoted, but the delegates did not have in mind the question of attendance. Your committee has thought that, inasmuch as more energy would be required to conduct the combination campaign than would be necessary if only the question of increase in membership were involved, the prizes should be larger. Furthermore, the local chapters will want to expend more funds in notices of meetings and in securing accurate records of attendance and larger prizes will make them more willing to appropriate those funds. For the above reason, your committee recommends total prizes of $500.00 which includes a fourth prize. In an organization of twenty-eight chapters, if all compete, four prizes is none too many.

The other matters contained in the resolution which is submitted herewith, are self-explanatory.

The following resolution is proposed:—

RESOLVED: That the American Society for Steel Treating, through its Board of Directors, hereby offers four prizes to be competed for by the local Chapters of the Society, and to be paid on the 15th of July, 1923 to the Chapters entitled thereto as follows:—

(a) First Prize of $200.00
(b) Second Prize of $150.00
(c) Third Prize of $100.00
(d) Fourth Prize of $50.00

The terms and conditions of the competition are:

1. The prizes shall be known as the Membership and Attendance Prizes for the years 1922-3.

2. The prizes shall be paid in cash to the four chapters showing the combination of the greatest percentage of net increase in membership from the period September 1, 1922 to June 30, 1923, and the best average attendance of members in good standing at the regular meeting of local chapters for the period beginning Dec. 1, 1922, and ending June 30, 1923. The combination standing of the several chapters in this contest will be determined on the basis of 50 per cent for percentage of net increase in membership between Sept. 1, 1922 and June 30, 1923, and 50 per cent for average attendance of members in good standing at the local chapter they shall check the matter up immediately and he shall adjust if possible meetings between Dec. 1, 1922 and June 30, 1923.

3. The basis to be used in determining the precentage of net increase in membership shall be the National Secretary's records of the membership in good standing of each local chapter on September 1, 1922 and June 30, 1923 respectively. The basis of average attendance shall likewise be the Na-

tional Secretary's records of membership in good standing of the several local chapters on the first day of each month beginning December 1, 1922, and ending June 30, 1923. The percentage of attendance at any regular meeting of the local chapters shall be the ratio which the number of members in good standing, as shown by the National Secretary's record, bears to the number of members in good standing according to the same records on the first of the current month.

For the purpose of this contest a member is considered in good standing until the local secretary is notified by the National Office that the sending of TRANSACTIONS has been stopped for nonpayment of dues.

Nor shall a person be deemed a member until he shall have presented his application to the local chapter and paid at least 6 months' dues.

4. The National Secretary shall, on or before November 15, 1922, send notices to all chapters giving them the particulars of this contest. He shall also before December 1, 1922, adjust with the several chapters the number of members in good standing of the several chapters as on September 1, 1922 and December 1, 1922. Each month after December 1, 1922, he shall within five days after the first of the month notify the chapters of the number of members in good standing of each chapter on the first day of each month.

5. If the local chapters dispute in any way the Secretary's records they shall check the matter up immediately and he shall adjust if possible the difficulties, and refer any matter which he cannot adjust to the Board of Directors for final decision.

6. Members not in good standing shall not count in competition. When any member is not in good standing according to the *Constitution and By-Laws* of the Society, he shall be deemed to be no longer a member of the local chapter and the local chapter will be deemed to have lost such member. On restoration of good standing he shall count as a new member.

7. Within five days after each regular meeting of a local chapter, such chapter shall send to the National Secretary a statement verified by the chairman and secretary of the local chapter showing the membership of such local chapter in good standing on the first of the current month and the number of such members in attendance at the meeting. The National Secretary shall check such certificate, comparing same carefully with his records and those of the local chapter, and adjust any discrepancies that may occur between his records and the records and certificate of the local chapter. Any matters he may not be able to adjust he shall refer to the Board of Directors for final decision.

New sustaining members shall count as 2½ in the competition for the increase in membership and in the attendance competition shall be counted as one (1).

Failure for ten days after request by the National Secretary to transmit the certificate above mentioned shall disqualify such chapter from further competition in this contest.

A chapter to be eligible in this contest, must hold at least six monthly meetings in the period from December 1, 1922 to June 30, 1923.

8. In order accurately to prepare the certificate last mentioned, the local chapters will be required to circulate, at each meeting, attendance slips which shall show the name and address of the person in attendance and whether or not he is a member of the local chapter. Such attendance slips

shall be signed by those in attendance and be collected by the Secretary, or his assistants, and after verification by him shall be forwarded to the National Secretary with the certificate above mentioned.

9. All matters of detail and all rules of competition not inconsistent with the above shall be arranged for and made by the Board of Directors of the National Society.

10. The Board of Directors shall finally award the several prizes to the chapters entitled thereto. The Board shall also finally decide all matters of dispute that may arise in connection with this contest.

## BOSTON CHAPTER

The Boston Chapter of the American Society for Steel Treating held its first meeting on October 17th at 7:30 p. m. at the plant of the New England Metallurgical Corporation, Andrews Square, South Boston. The speaker, Mr. J. W. Black, foreman of the hardening room of the Geometric Tool Company, New Haven, Connecticut, talked on the subject of "Hardening Twenty-Five Years ago and Today". Mr. Black's presentation was indeed interesting and was very instructive. Following the paper of the evening, all of the members were conducted on a tour through the plant of the Geometric Tool Co., while it was in operation. The visitors observed surface combustion furnaces, Bellis Lava Process and other interesting heat treating equipment which was in operation.

## CINCINNATI CHAPTER

The Cincinnati Chapter held its regular monthly meeting on October 27th at 8:00 o'clock in the Ohio Mechanics Institute. The speaker for the evening was Mr. John H. Ames of the Lunkenheimer Company who gave a talk on "Pyrometers" which was a general discussion of the commercial types of pyrometers. Mr. Ames presented his subject in a very capable manner and an interesting discussion followed the presentation of his paper. The Cincinnati Chapter has outlined a very interesting course of papers for the coming season. The subjects that will be discussed during the year are: Blast Furnace and Pig Iron; Grading of Iron; Pig Iron for the Foundry; Autogeneous Welding; Metallurgical Furnaces & Fuels; Stainless Steel; Inspection of Foundry; Case Hardening; Auto Trip to American Rolling Mills, Middletown, Ohio; and finally the Annual Dinner and Meeting.

## CLEVELAND CHAPTER

The Cleveland Chapter held its first monthly meeting October 17th in the Cleveland Engineering Society Rooms in the Hotel Winton. The paper for this meeting was presented by R. S. Archer, Metallurgist of the Aluminum Company of America. The title of Mr. Archer's paper was "The Slip Interference Theory of the Hardening of Metals". Mr. Archer presented his theory in a very clear and logical manner, and after the presentation of the paper a discussion of the theory was in order. There were many interesting questions asked Mr. Archer, and he was able to answer in a very convincing way points in objection to his theory. Dr. Jeffries and Mr. Archer are still working on this theory and it is hoped that we shall hear from them at a later date.

Mr. W. H. Eisenman, National Secretary of the Society, gave a brief account of the activities of the Detroit Convention. The next meeting

of the Cleveland Chapter will be held November 21 at which time the Cleveland Chapter will hold a joint meeting with the Cleveland Engineering Society, the Society of Mechanical Engineers and the Society of Mining and Metallurgical Engineers. Dr. John A. Mathews, President of the Crucible Steel Company of America, will present his paper entitled "Alloy Steels".

## HARTFORD CHAPTER

The September meeting of the Hartford Chapter was held on Friday, Sept. 15. Mr. Stanley P. Rockwell addressed an audience of 72 on the subject of "Furnaces, their Design and Construction". A considerable portion of his talk was given up to the calculation of the efficiency of a furnace, and in the discussion of this phase of the problem, the electric furnace showed up best. The talk was illustrated by slides showing standard designs and methods of producing uniformity in large furnaces.

A short discussion on the subject of carburizing followed, in which the recent impact tests made by Mr. d' Arcambal were described. A resume was also given of the work of Ehn and McQuaid on irregularities in carburizing steel.

Mr. W. D. Fuller read abstracts of metallurgical and heat treatment articles which appeared in the technical and trade journals during the Summer.

During the meeting cards were passed out so that members might jot down questions that occurred to them while the speaker held the floor, and these were handed to the chairman for discussion afterward. Cards were also passed out to obtain the names, addresses, and company connections of those present. These cards were subsequently collected and thoroughly shuffled, then one card was drawn from the pile; the person whose card was drawn to receive a prize in the form of a book on heat treatment, a subscription to a metallurgical or heat treating journal, or, to non-members, a credit of one-half years dues in the society. The drawing was won by Mr. W. R. Bowes, who selected a subscription to "Forging and Heat Treating", to be circulated throughout his plant each month.

The meeting was then addressed by Mr. A. W. F. Green, the visiting chairman of the Philadelphia Chapter, who called for a square deal for the speakers at these meetings. After a man had spent some time in preparing a paper for a meeting, he was entitled to a chance to answer criticism, that is, if there was any criticism to be made of his paper, it should be made in open meeting, during the discussion, where the speaker would have a chance to defend himself and his views. Such discussion would make the meetings more helpful.

The October meeting of the chapter was held on October 13th, in the Hartford Electric Light Co. Hall. This hall is ideal for the purposes of the chapter, and the Electric Light Co. has kindly offered the use of it for the entire year.

The speaker of the evening was Mr. H. C. Goodwill, superintendent of the Die Department of R. Wallace and Sons, Wallingford. Mr. Goodwill gave a short talk covering the types of steel used for their various types of dies, described the heat treatment applied, and the heat

treating equipment used. After his brief talk, he called for questions, and spent over an hour on his feet thereafter answering the questions inspired by his talk. Without a doubt, this meeting was one of the most successful the chapter has had, judging by the interest shown in the discussion, in which the speaker amplified what he had already said, and added much more information requested by individuals in his audience.

Three questions, taken from those printed in the back of the "Transactions", were offered for discussion, as follows:

QUESTION NO. 1. What regulations are recommended to reduce the fire hazzard of quenching tanks?

QUESTION NO. 2. May tools be heat treated properly in a furnace in which copper is present?

QUESTION NO. 3. What is the difference between red annealed and blue annealed sheet steel?

1. It was suggested that an extinguisher system, such as the "Foamite" be installed. Or, another method suggested was to have a pumping system that would empty the oil into a cooling tank at some distance from the quenching tank.

2. The experience of those present seemed to indicate that the presence of copper would not affect the tools. Cases were cited where tools were copper-plated for engraving or other purposes, and then hardened. The parts coated with copper appeared to respond properly to the hardening treatment. A note on the vaporization of copper at heat treating temperatures recently appeared in Chemical and Metallurgical Engineering but no ill effects were reported.

3. While some difference of opinion existed, it was believed that the terms "Red Annealed" and "Blue Annealed" referred to the color of the scale on the annealed sheet. The blue or black scale usually results when the material is pack-annealed, and the red when annealed without packing. It was also remarked that high carbon steel shows a greater tendency toward coming out red after open annealing than the lower carbon steels.

The last feature of the evening was the drawing for the prize, using the attendance cards. Mr. Lanning was the winner of his choice of a number of heat treating books, or current publications.

## INDIANAPOLIS CHAPTER

The regular monthly meeting of the Indianapolis Chapter was held in the Directors Rooms of the Indianapolis Chamber of Commerce, Monday evening, October 10th.

Preliminary to the regular meeting a short executive meeting was held.

At 8:00 the regular meeting was called to order by the chairman and a short business discussion followed. A committee was appointed with power to act in connection with having the next meeting a dinner meeting at the Hoosier Athletic Club.

Prof. John Keller of Purdue University spoke in connection with a proposed extension course which Purdue University hopes to establish

in conjunction with Indianapolis Chapter.

The meeting was then turned over to Mr. H. B. Northrup, Metallurgist for the Diamond Chain & Mfg. Co., who spoke on the subject of "Iron Ore and the Blast Furnace". His subject was illustrated by lantern slides loaned to him by Penn State College. His talk covered the subject from the early discovery of iron ore down to the present day practice. Mr. Northrup's paper was made all the more interesting because of the fact that he has worked personally in some of the mines.

The next meeting of the Chapter is to be held Nov. 13th and the subject will be "Practical Applications of Metallography". A microscope will be at hand to facilitate the study of the specimens.

## LEHIGH VALLEY CHAPTER

The Lehigh Valley Chapter held a meeting on Monday evening, October 23rd, at Bethlehem Steel Company, Battery Building, Bethlehem, Pa. The speaker for this meeting was Mr. A. Koleser, of the Ingersoll-Rand Company. who discussed "Pyrometry". Mr. Koleser handled his subject in a very capable manner and developed a very interesting discussion at the conclusion of his paper.

## MILWAUKEE CHAPTER

The Milwaukee Chapter of the American Society for Steel Treating held its October meeting on the 19th, at 8:00 p. m. at the Blatz Hotel. The paper of the evening was presented by Mr. R. J. Doty of the Sivyer Steel Casting Company. The subject of Mr. Doty's paper was "Some Developments in the Annealing of Steel Castings". Mr. Doty is a well known foundry man and his paper and discussion which followed were well worth hearing.

## NEW YORK CHAPTER

The New York Chapter held its October meeting in the Merchants' Association Rooms, 9th floor of the Woolworth Building Wednesday, the 18th at 8:00 p. m. The program for this meeting was a paper by Mr. W. J. Merten, Metallurgist of the Westinghouse Electric & Mfg. Company of Pittsburgh, Pa. The title of Mr. Merten's paper was "The Heat Treatment of Helical Springs" especially applied to railway equipment. Mr. Merten has had many years of experience along this line and spoke with authority on the subject.

## NORTHWEST CHAPTER

The first meeting of the Northwest Chapter for the ensuing year was held Tuesday evening October 17th at 7:30 p. m. in the Manufacturers Club rooms, 200 Builders Exchange, Minneapolis.

Norman Conn, Minneapolis Steel & Machinery Company, who with O. E. Harder attended the Detroit Convention of the National Society as delegates from this Chapter, reported upon what was accomplished at the convention and reviewed some of the plans that the National Society has decided upon to stimulate and encourage the activities in the various Chapters.

A three reel motion picture, produced by the Interstate Iron and

Steel Company of Chicago, entitled "The Making of Steel," was shown at this meeting for the second time in this country. It was first shown at the Detroit Convention where it was pronounced a distinct contribution to the science of steel treating as it presents the latests improvements and refinements in the art.

The meeting was well attended and a very enjoyable and profitable evening was had by all.

## PHILADELPHIA CHAPTER

The Philadelphia Chapter held its September meeting Friday evening, the 29th, at the Engineers' Club. The program for the evening was entitled "Ten Talks on Philadelphia Topics" presented by several Philadelphia people. The topics which were discussed were as follows: Motion Pictures—"Some Steps in Building a Modern Locomotive" by Mr. Walter Adamson, Test Department, Baldwin Locomotive Works, Philadelphia; "The Old and New Heat Treater" by C. R. Carey, Sales Manager, Leeds & Northrup Company, Philadelphia; "Kinks in Heat Treating Furnaces" by Mr. F. A. Hall, Engineer, F. J. Ryan Co., Philadelphia; "Problems in Treating Steel for Auto Bodies" by Dr. Geo. L. Kelley, Metallurgist, Edward G. Budd Mfg. Company, Philadelphia; "Automatic Temperature Control" by Mr. R. P. Brown, President Brown Instrument Company, Philadelphia; "Tools and Production" by Mr. H. D. Vandegrift, Superintendent of Tools, Miller Lock Company, Philadelphia; "Steel and Philadelphia," by Mr. G. P. Bible, H. T. Potts Company, Philadelphia.

This meeting was very well attended, about 125 people in all.

The Philadelphia Chapter held a meeting on Friday evening, October 27th, at 8:00 p. m. in Engineers' Club rooms. The paper for this meeting was presented by Mr. Sam Tour, Metallurgist of the Doehler Die Casting Company, Brooklyn, N. Y., entitled "Salt Baths for Heat Treating." This paper proved to be very interesting and instructive and one which brought out considerable good, interesting discussion. Mr. Arthur L. Collins, secretary of the chapter, presented a paper entitled "Thermal Critical Points." Mr. Collins' paper likewise brought out considerable interesting discussion.

## PITTSBURGH CHAPTER

The Pittsburgh Chapter of the Society held a meeting on October 10th at which time, Mr. W. J. Merten of the Westinghouse Electric and Manufacturing Company presented a paper entitled "The Development and Manufacture of Helical Springs for Flexible Drives". This meeting was well attended, and the discussion which followed Mr. Merten's paper was indeed interesting.

## RHODE ISLAND CHAPTER

The first meeting of the Rhode Island Chapter for the year 1922-23 was held on October 18th at 8 p. m. in the rooms of the Providence Engineering Society. The paper for this meeting was presented by S. W. Parker, Metallurgist, Wheelock Lovejoy & Company, Cambridge, Mass. The subject of his paper was "The Manufacture of Steel." Mr. Parker's paper was indeed interesting and pointed out many of the difficulties which are encountered in the manufacture of steel.

## ROCHESTER CHAPTER

The October meeting of the Rochester Chapter was held in the rooms of the Rochester Engineering Society October 9th. Mr. W. W. Lewis, of the Development Department of the American rolling Mills Company, Middletown, Ohio, lectured during the exhibition of the four reels of motion pictures taken at their plant which was entitled "The Rolling of Steel". This meeting was the second of a series of meetings dealing with steel and its heat treatment from the ore through to the finished product. The meeting was well attended and considable and valuable discussion was heard following the presentation of the film.

## ST. LOUIS CHAPTER

On Monday evening, October 16th, the St. Louis Chapter held its regular monthly meeting in the American Annex Hotel. Prof. John F. Keller was the speaker of the evening. The subject of his paper was "Why Steel Warps". Professor Keller who is an expert along the line of steel treating presented his paper in a very clear and logical manner.

## SCHENECTADY CHAPTER

The first monthly meeting of the Schenectady Chapter was held October 17th. The speaker of the evening was Mr. Paul Doerr of the E. F. Houghton & Company who spoke on "Principles and Applications of Carburizing, Quenching and Tempering Mediums". The meeting was very well attended, and following Mr. Doerr's paper a lively discussion took place. The Schenectady Chapter members are taking active steps to increase their membership so that they may advance their position in the standing of chapters list.

## SOUTH BEND

The South Bend Chapter at the October meeting has, we believe, started an innovation in Chapter activities.

The October meeting was held on the 10th, at the Studebaker cafeteria, Plant No. 2. The meeting was started with several numbers rendered by a well known saxophone sextette. A brief business meeting was held, after which the members and guests present enjoyed several musical numbers received by radio at the meeting.

At 9:00 o'clock, Mr. W. E. Ruder, M. E. of the General Electric Co., Schenectady, N. Y., addressed the meeting on the subject, "The Fatigue of Metals." This address was received by radio, and everyone present was able to hear perfectly. This talk, of course, was broadcasted so that radio fans for miles around South Bend could listen in, the talk being general and not too technical. This, in addition to being a novelty, also gave much publicity to the South Bend Chapter and to the Society as a whole.

After the talk by radio, the speaker was brought back to the Studebaker plant, where he addressed the meeting on the same subject in detail, and by the use of slides.

A general discussion was held following this talk, after which the meeting was adjourned.

In view of the fact that on this day we had the most disagreeable weather,

we believe we had a very successful meeting, there being 75 members and guests present. Fully that many more stayed away due to the inclement weather.

The Chapter wants to go on record as favoring Cleveland for the next National Convention, providing Cleveland wants the Convention.

## SPRINGFIELD CHAPTER

The Springfield Chapter held its second monthly meeting Friday evening, October 20th, in the Chamber of Commerce Building, at which time Mr. Geo. P. Moore, Metallurgist of Wallace Barnes Company, Bristol, Connecticut, delivered a paper entitled "Wire and Spring Manufacture and Treatment." Mr. Moore represents one of the largest spring companies in the East, and has specialized for many years on the metallurgy of spring manufacture and is considered an authority on steel springs. Following Mr. Moore's paper a very interesting discussion was held.

## SYRACUSE CHAPTER·

The Syracuse Chapter of the Society held its October meeting at the Yates Hotel Friday evening, October 13th. The program for this meeting was a moving picture film illustrating the "Manufacture of Sheet Steel." Mr. R. D. Black, Buffalo District Sales Manager of the American Rolling Mill Company, lectured during the exhibition of these pictures, as the pictures were taken at the plant of the company Mr. Black represents.

## TRI CITY CHAPTER

The Tri City Chapter of the Society held a meeting on October 26th in the Davenport Chamber of Commerce at 8:00 p. m. The program for this meeting was a paper entitled, "Furnaces and Their Application in Heat Treatment" by W. C. Squire, Engineer of the W. S. Rockwell Company, New York City. Mr. Squire's paper was indeed interesting and developed some of the various designs in the different types of heat treating furnaces.

## WASHINGTON CHAPTER

The September meeting of the Washington Chapter was held Friday, the 22nd at 8:00 p. m. in the Auditorium of the New Interior Department Building. The program for this meeting consisted of two sections of motion pictures, part 1--"The Manufacture of Tool Steel" by the Atlas Crucible Steel Company, Dunkirk, New York. This picture illustrated in detail the various operations incidental to the production of a high grade steel product and the extreme care necessary for successful accomplishment. Part 2 entitled "Uses and Abuses of Twist Drills" by the Cleveland Twist Drill Company, Cleveland, Ohio, illustrated the application of a particular type of tool to industrial processes, and illustrated those practices which frequently shorten the useful life of good tool steels incorporated into carefully made tools. This meeting was well attended, and all who were present had a very enjoyable, entertaining and instructive evening.

The October meeting of the Washington Chapter was held in the Auditorium of the New Interior Department Building at which time Mr W. J. Merten, Research Engineer of the Westinghouse Electric an:

Manufacturing Company, East Pittsburgh, Pa., presented a very capable paper entitled "The Development of Helical Springs for Locomotive Flexible Drives". Mr. Merten has had extensive experience in the development of heat treatment practice as applied to large size coil springs, particularly for railway service. While these problems closely parallel those encountered in the preparation of heavy springs for ordnance purposes, there are essential differences in the relative importance of the cost of material, cost of manufacture, load tolerances, etc. Mr. Merten developed his subject in a very comprehensive manner, and it was followed by an interesting discussion.

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## Question Box

(*Continued from Page* 255)

*QUESTION* 50. *What is the chemical composition of the so-called "stainless steel" used for cutlery purposes?*

ANSWER. According to the latest information we have on the subject, the analysis, that is recommended for stainless steel to be used in cutlery manufacturing is as follows: Carbon .30 to .45 per cent; Chromium 13 to 16 per cent; Phosphorus and Sulphur below .03 per cent; Silicon .30 per cent; and Manganese .50 per cent.

## ADDRESSES OF NEW MEMBERS OF THE AMERICAN SOCIETY FOR STEEL TREATING

EXPLANATION OF ABBREVIATIONS. M represents Member; A repesents Associate Member; S represents Sustaining Member; J represents Junior Member, and Sb represents Subscribing Member. The figure following the letter shows the month in which the membership became effective.

### NEW MEMBERS

ABBOTT, J. H., (M-9), 1969 Seward Ave., Detroit, Mich.
ADAMS, W. E., (A-10), 12 Sigourney St., Boston, Mass.
AFFLECK, G. S., (M-9), 278 E. Canfield Ave., Detroit, Mich.
ALLA, E. S., (M-10), 13530 Thomson Ave., Highland Park, Mich.
ALLINGTON, A. L., (M-10), 132 Cedar St., Wyandotte, Mich.
BAILY, T. E., (A-10), R. F. D. No. 1, Alliance, Ohio.
BATIE, J. E., (M-10), 3615 Military Ave., Detroit, Mich.
BEAN, L. G., (A-10), 514 Old South Bldg. Boston, Mass.
BENNETT, A., (M-10), 29 Little Ave., Weston, Ont., Can.
BENNETTS, E., (M-10), 5929 Commonwealth Ave., Detroit, Mich.
BLACKBURN, C. J., (M-9), 52 Garfield Ave., Detroit, Mich.
BLACKINGTON, R. C., (M-10), C. H. Wills & Co., Marysville, Mich.
BRAY, W. J., (M-10), 311 Chestnut St., St. Paul, Minn.
BRUCE, A. J., (A-11), 132 E. Woodbridge St., Detroit, Mich.
BURKEMER, M. E., (A-10), 333 Frankfort Ave., Cleveland, O.
BUTT, H., (M-10), 1156 Leader-News Bldg., Cleveland, O.
CAMPBELL, J. F., (M-10), Amer. Malleables Co., Lancaster, N. Y.
CARPENTER, C. B., (M-10), Colorado School of Mines, Golden, Colorado.
CHAMBLISS, G. S., (M-10), Tool Steel Gear & Pinion Co., Cincinnati, O.
CHERNISKI, A. L., (M-10), 3258 Hanley Ave., Hamtramck, Mich.
CHERRY, R. M., (M-10), 1003 Nott St., Schenectady, N. Y.
CHESTERFIELD, P., (M-10), 261 St. Aubin Ave., Detroit, Mich.
CHRISTIAN, R. E., (M-10), 230 Elmhurst Ave., Highland Park, Mich.
COLEMAN, S. C., (M-9), Rich Steel Prod. Co., Battle Creek, Mich.
CONN, N., (M-10), 3200 Calhoun Ave., Minneapolis, Minn.
COOLEY, A. C., (M-10), General Elec. Co. Research Laboratory, Schenectady, N. Y.
COWAN, P. J., (M-10), National Malleable Co., Front St. and Payne Ave., Toledo, Ohio.
CUMMINGS, E. E., (M-10), Delco Light Co., Dayton, Ohio.
DAVIS, H. H., (A-10), 6 Sorrento St., Springfield, Mass.
DAWSON, R. T., (M-10), Adams Axle Co., Finlay, O.
DE HAVEN, H. E., (M-10), 8114 Lawton Ave., Detroit, Mich.
DEMERS, I. J. B., (M-10), 441 Stryker Ave., St. Paul, Minn.
DEUBLE, N. L., (M-10), 1408 N. Cleveland Ave., Canton, Ohio.
DIETZ, C. W., (M-10), 112 E. Dayton St., South Bend, Ind.
DOWNES, T. W., (M-10), 2524 S. 19th St., Philadelphia, Pa.
DUNN, L. C., (A-10), Montgomery Chem. Wks., Detroit, Mich.
DUNSMORE, R. E., (M-10), 4119 S. Western Ave., Los Angeles, Cal.
EDWARDS, S. H., (M-10), Muncie Prod. Div., Muncie, Ind.
FAWLEY, A. E., (M-10), 3710 Hamilton St., Philadelphia, Pa.
FINDLATER, J. J., (M-10), 100 Tuxedo Ave., Highland Park, Mich.
FOX, JOHN, (M-10), Henry Clay Hotel, Detroit, Mich.
GARDNER, G. E., (M-10), 2278 Detroit Ave., Toledo, O.
GINKEL, F., (M-10), Marseilles Works, Deere Company, E. Moline, Ill.
GOLLY, F. B., (M-9), Y. M. C. A., Detroit, Mich.
GRAVES, W. H., (M-10), Packard Motor Car Co., Detroit, Mich.
GREENE, H. L., (M-8), 1434 Lincoln Ave., Toledo, O.
GRIGGS, E. R., (M-10), Lufkin Rule Co., Saginaw, Mich.
GRISWOLD, H. C., (M-11), Blackburn Pl., Summit, N. J.
HAGBERG, O. F., (M-10), 26 Salisbury St., Worcester, Mass.
HAISLIP, R. E., (M-9), 1291 Fairview, Detroit, Mich.
HAMILTON, D. W., (M-9), 1115 W. Allegan St., Detroit, Mich.
HARVEY, D., (M-11), 109 Dewey Ave., Pittsburgh, Pa.
HASSIG, E., (M-10), 247½ 18th St., Milwaukee, Wis.

HAYES, T. D., (M-10), Central Steel Co., Massillon, O.
HEALY, J. A., (A-10), 1504 Methyle St., Beachview, Pittsburgh, Pa.
HEISER, L. W., (M-10), 4919 Ogden Ave., Detroit, Mich.
HERMANN, E., (M-12), R. H. Hassler, Inc., Indianapolis, Ind.
HOKANSON, M., (M-10), Marshall-Wells Co., Duluth, Minn.
HOLTON, H. L., (M-10), Advance Rumely Co., Battle Creek, Mich.
HUNGELMANN, A., (M-10), 345 Pierce St., Gary, Ind.

IRELAND, D. B., (M-11), Ireland & Matthews Mfg. Co., Detroit, Mich.

JACOBSEN, A. E., (Jr.-10), 1265 75th St., Brooklyn, N. Y.
JONES, D. J., (A-10), 3319 Park Ave., Indianapolis, Ind.
JUTHE, K. A., (A-10), 149 Tremont St., Boston, Mass.

KAHN, N. H., (M-10), 452 Birkle Ave., Bethlehem, Pa.
KEENEY, R. M., (A-10), Westinghouse Electric & Mfg. Co., Boston, Mass
KELLER, F., (M-10), No. 1 Prevost Ave., Keyport, N. J.
KERR, R. B., (M-10), 919 43rd St., Rock Island, Ill.
KING, W. C., (M-10), 1135 Main St., Bethlehem, Pa.
KLEMZ, C. W., (M-10), Riter-Conley Co., Leetsdale, Pa.
KLINE, C. B., (M-10), 1524 Dormant Ave., South Hill Sta., Pittsburgh, Pa.
KOTTNAUER, E. H., (A-10), Crucible Steel Co. of America, Detroit, Mich.
KUENY, A. A., (M-10), Studebaker Corp., Plant No. 5, Detroit, Mich.

LARIME, E. J., (M-8), 5144 Belvidere Ave. Detroit, Mich.
LEFFLER, W. W., (M-10), Central Steel Co., Massillon, O.
LEDIN, J., (M-10), 2210 Giddings St., Chicago, Ill.
LEE, H., (A-10), 383 Concord Ave., New York City.
LEE, I. H., (M-8), 1439 W. Grand Blvd., Detroit, Mich.
LESPERANCE, L. J., (M-10), 1206 Beniteau Ave., Detroit, Mich.
LINDSEY, W. M., (M-10), 317 N. Lincoln Ave., Massillon, O.
LOUDENBACK, C. I., (A-10), 2407 1st Nat'l Bk. Bldg., Detroit, Mich.

MACFARLAND, A. F., (S-11), 5219 Trumbull Ave., Detroit, Mich.
MACGREGOR, I., (M-10), Sanderson Brothers, Sheffield, England.
MANN, E. O., (M-10), 2626 Northwestern Ave., Detroit, Mich.
MANN, M. A., (A-10), 8243 Wilson Ave., Detroit, Mich.
MAREMONT, M. O., (M-10), Maremont Mfg. Co., Chicago, Ill.
MARLOW, J. S., (A-8), 7 Mayflower Apts., Indianapolis, Ind.
MATHEWSON, C. H., (M-10), Yale University, New Haven, Conn.
McADAM, D. J., (M-10), Naval Engr. Experimental Sta., Annapolis, Ind.
McCABE, J. C., (M-10), Dept. Safety Engr., City Hall, Detroit, Mich.
McCLUNG, H. F., (M-10), Studebaker Corp., Plant No. 3, Detroit, Mich.
McDONALD, J. A., (M-8), 4501 Mt. Clair Ave., Detroit, Mich.
McINNES, COLIN, (A-10), Colonial Steel Co., Pittsburgh, Pa.
McKENZIE, E. M., (M-11), 5909 Quimby Ave., Cleveland, O.
McMULLAN, O. W., (M-10), 2942 Cass Ave., Detroit, Mich.
MITCHELL, D. E., (M-8), 2377 E. Grand Blvd., Detroit, Mich.
MORGAN, J. J., (M-10), Naval Air Station, Hampton Roads, Norfolk, Va.
MORGENTHAU, WM., (M-8), 2664 Eastlawn Drive, Flint, Mich.
MOSS, H. W., (S-10), 545 Book Bldg., Detroit, Mich.
MUNN, C. G., (M-10), Amer. Twist Drill Tool Co., Detroit, Mich.

NESSER, J. O., (M-10), 7620 Kipling Ave., Detroit, Mich.
NIERODT, W. J., (M-10), 262 National St., Elgin, Ill.
NORTHRUP, H. M., (M-8), Hudson Motor Car Co., Detroit, Mich.

OLDHAM, E. L., (M-11), 3734 E. 78th St., Cleveland, Ohio.
OBERTING, CHAS., (M-4), 1134 Kelly St., Indianapolis, Ind.
ODEMAR, F. W., (A-9), 305 Merchants Bk. Bldg., Indianapolis, Ind.

PARSONS, J. C., (M-9), American Auto Parts Co., Detroit, Mich.
PECKHAM, E. G., (M-10), Armstrong Spring Co., Flint, Mich.
PETERSON, A. K., (M-7), 224 Summit St., Rockford, Ill.
PETERSON, J. W., (M-11), 448 Underwood St., Rockford, Ill.
PLAGE, WM., (A-11), 87 Vermont St., Brooklyn, N. Y.
POTTER, O. D., (M-10), 653 Flint Park Blvd., Flint, Mich.
PROCTOR, C. H., (A-9), Roessler & Hasslacher Chem. Co., New York City.

RICHARDS, W., (M-10), 414 Pawnee St., Bethlehem, Pa.
ROBINSON, A. H., (M-10), 45 Mathews St., Pontiac, Mich.
ROGERS, C. R., (M-9), C. L. Best Tractor Co., San Leandro, Cal.

ROLF, R., (M-9), 1160 E. 74th St., Cleveland, Ohio.
ROSS, WM. H., (Jr.-10), 6465 Trumbull Ave., Detroit, Mich.
ROWDEN, C. S., (M-10), 587 Summer Ave., Newark, N. J.
RUPPEL, W. A., M-10, Firth-Sterling Steel Co., New York City.

SAGAR, E. S., (M-10), Kelsey Wheel Co., Inc., Detroit, Mich.
SANDMEYER, J. E., (M-10), Youngstown Sheet & Tube Co., Youngstown, O.
SATOH, K., (M-10), Tokyo Galvanizing Co., Ltd., Tokyo, Japan.
SCARBROUGH, H. E., (A-10), General Elec. Co., Chicago, Ill.
SCHEID, A. J., (M-10), 137 Sycamore St., Milwaukee, Wis.
SCHERMER, N. H., (A-9), 55 Colorado Ave., Highland Park, Mich.
SCHOESSEL, C. A., (M-10), John Deere Harv. Co., E. Moline, Ill.
SECOR, J. M., (M-10), Ingalls Shepard Division, Wyman Gordon Co., Harvey, Ill.
SHAFER, W. H., (M-11), 2879 Erie Ave., Cincinnati, O.
SHEPARD, R. L., (M-10), 141 Montana W. Detroit, Mich.
SINCLAIR, C. E., (M-10), 3615 Military Ave., Detroit, Mich.
SMITH, A. J., (M-10), 4210 Van Dyke Ave., Detroit, Mich.
SMITH, S. S., (A-10), 620 E. Hancock St., Detroit, Mich.
SPENCER, M. P., (A-10), 608 W. Adams St., Chicago, Ill.
SPIEGEL, H. W., (A-8), 1776 W. Lafayette Blvd., Detroit, Mich.
STALLKAMP, R. F., (M-10), 4044 Commonwealth Ave., Toledo, Ohio.
STARGARDTER, A. R., (M-9), Marlborough Apts., Baltimore, Md.
STEPHENSON, R. L., (M-10), 964 Stimson Pl., Detroit, Mich.
STEVENS, D., (M-8), 2236 Garland Ave., Detroit, Mich.
STUCK, H. D., (M-10), 184 Abbott St., Lawrence, Mass.

TAYLOR, J. W., (A-10), 2009 Oliver Bldg., Pittsburgh, Pa.
TEEL, H., (A-10), 4110 Helen Ave., Detroit, Mich.
TERWILLIGER, E. S., (M-11), 163 N. Hamilton St., Poughkeepsie, N. Y.
THORPE, C. N., (M-10), Bagshaw & Field, Ltd., Philadelphia, Pa.
TOMPKINS, C. S., (S-10), 1219 Dime Bk. Bldg., Detroit, Mich.
TOMSETT, G. F., (M-10), 6026 Maxwell Ave., Detroit, Mich.

VANDERGRIFT, H. D., (M-10), 4638 Richmond St., Bridesburg, Pa.
VAN CLEVE, A. E., (M-11), 56 S. Maple Ave., E. Orange, N. J.
VAN DALSON, E. S., (M-10), Dodge Bros., Detroit, Mich.
VINCENT, R. E., (M-5), 3131 Bellevue Ave., Detroit, Mich.
VOORHEES, E. C., (M-9), Erie Forge Co., Erie, Pa.

WADHAMS, A. J., (S-10), International Nickel Co., New York City.
WALLIS, W. B., (M-10), Pittsburgh Elec. Furnace Corp., Pittsburgh, Pa.
WALKER, W. G., (M-10), 9601 American Ave., Detroit, Mich.
WALLS, F. J., (M-10), Wilson Fdry. & Mach. Co., Pontiac, Mich.
WEAVER, H. A., (A-10), Box 205, Carnegie, Pa.
WEBB, GEORGE, (M-11), 189 S. Whitney St., Hartford, Conn.
WEISS, H. S., (M-10), Sun Inn, Philadelphia, Pa.
WELLES, H. M., (M-10), Commercial Truck Co., Philadelphia, Pa.
WELSH, L. E., (M-10), 602 Penfield Bldg., Philadelphia, Pa.
WING, J. F., (M-10), 149 Tremont St., Boston, Mass.
WOOD, C. J., (A-10), 1443 Rosemont Ave., Chicago, Ill.
WOOD, L., (A-10), 809 Keystone Bldg., Pittsburgh, Pa.
WOODWARD, E. L., (M-10), 2201 Woolworth Bldg., New York City.

YOUNKINS, J. B., (M-10), 6472 Van Dyke Ave., Detroit, Mich.

ZAUCK, W. J., (M-10), R. No. 1, Trenton, Mich.
ZWAHL, C. E., (M-10), 27 E. Willis Luilado Apt., Detroit, Mich.

## CHANGES OF ADDRESS

ASTIE, L. R., from Box 130, Freeport, to 3502 Parkview Ave., Pittsburgh, Pa.
BARR, WM., from Hughes Tool Co., Los Angeles, to Regan Forge & Engr. Co., San Pedro, Cal.
BEAUDRY, R., from Mineral St. to 752 Washington St., Milwaukee, Wis.
BEELER, C. F., from 2066 E. 89th St. to 12005 Fairport Ave., Cleveland, O.
BIERMAN, G. H., from Nela Park Lab. to White Motor Co., Cleveland, O.
BLOXTON, A. M., from Chesapeake St. to Bureau of Standards, Washington, D. C.
BOLDUC, E. N., from Mills St. to 127 Wilcox Ave., Bristol, Conn.

BOSTWICK, H. C., from Newark Ave., Elizabeth, to 35 Sprence St., Cranford, N. J.
CARLSON, T., from Thomas St. to 1107 N. Leamnigton, Chicago, Ill.
CHABOT, J. M. T., from Dwight St., New Britain, Conn., to 23 Silver St. Suite 8, Waterville, Maine.
CLARK, H. H., from 225 Maple Ave., Oak Park, to 1501 Spencer Ave., Wilmette, Ill.
DUNHAM, G. S., from 39th and Gilpin Sts. to 1601 32nd Ave., Denver, Colo.
EVANS, F. J., from State St., Springfield, Mass., to 366 Gerard Ave., New York City.
FLOOD, W. E., from W. 73rd St., Chicago, to 1015 Mapleton, Oak Park, Ill.
GROSSMANN, M. A., from Electric Alloy Steel Co. Charleroi, Pa., to Atlas Steel Corporation, Dunkirk, N. Y.
GRAVELIN, A., from Slocum Ave. to 529 Gifford St., Syracuse, N. Y.
HARMON, B. G., from Watervliet Arsenal to 6 N. Michigan Ave., Chicago, Ill.
HARTMAN, from Chamber of Commerce Bldg. to 1146 Morse Ave., Chicago, Ill.
HOOD, H. T., from 4th Ave., Detroit, Mich., to 115 S. Pennsylvania Ave., Greensburg, Pa.
HOYT, S. L., from Brown Ave., Willoughby, O., to Research Laboratory, General Electric Co., Schenectady, N. Y.
HOLLANDER, J. A., from Menasha Mach. Mfg. Co., Menasha, Wis., to 1613 Humboldt Blvd., Milwaukee, Wis.
JOSEPH, C. F., from W. Ionia St., Lansing, Mich., to 630 S. 4th Ave., Saginaw, Mich.
KELLER, J., from Lewis Institute, Chicago, to Purdue University, Lafayette, Ind.
KEIDEL, E. E., from W. 97th St. to 1080 E. 141st St., Cleveland, O.
KINGSBURY, J. A., from Leland Ave., South Bend, to 503 W. Third St., Mishawaka, Ind.
KNAPP, J. H., from Fifth St., Santa Monica, to 769 S. Central Ave., Los Angeles, Cal.
KOEPPEN, E. W., from Warren Ave. to 1944 Adams St., Chicago, Ill.
LEWIS, C. B., from Canfield Ave. to 42 E. Willis Ave., Detroit, Mich.
MACKENZIE, W. J., from Blackstone Ave. to 5437 University Ave., Hyde Park Sta., Chicago, Ill.
MATHUR, P. N., from Florence Ave. to 251 Garrison, Dearborn, Mich.
McBURNEY, J. W., from West Tech. High School to Cleveland Board of Education, 6th and Rockwell, Cleveland, Ohio.
McINERNEY, W. I., from Crucible Steel Co. to Box 221, Midland, Pa.
MULL, E. K., from Y. M. C. A. Bldg., Rochester, N. Y., to 219 Apsley St., Philadelphia, Pa.
MULL, H. C., from Michigan Ave., Chicago to c/o Warren Tool & Forge Co., Warren, O.
MURDO, E. E., from Park Mfg. Co., St. Paul, to 276 Emerson Ave., Minneapolis, Minn.
NICKERSON, FRANK, from Midvale Steel & Ordnance to 10 Hastings Terrace, San Francisco, Cal.
NOVAK, A., from Kennedye Ave. to 10706 Mt. Auburn Ave., Cleveland, Ohio.
OVENS, WM., from Birmingham to 4 Croft St., Galashiels, England.
PECK, C. A., from Monroe St. to 508 S. Rush St., South Bend, Ind.
PHILLIPS, W. W., from Glenwood Ave. to 89 Bedford St., Rochester, N. Y.
RIECKEL, WM., from Whittelsly Ave. to 28 N. Elm St., Wallingford, Conn.
RIEGER, W. H., from Sizer Forge Co. to 89 Donaldson Rd., Buffalo, N. Y.
ROBERTS, J. H., from Electric Alloy Steel Co., Youngstown, O., to Atlas Steel Corporation, Dunkirk, N. Y.
RODNEY, K. R., from Highland Iron & Steel Co., Terre Haute, Ind., to Chrome Steel Works, Chrome, N. J.
ROOT, H. H., from Barnard Ave., Watertown, to 259 Newbury St., Boston, Mass.
SPELIE, J. E., from Harvard Ave. to 4144 Clarendon Ave., Chicago, Ill.
STIVERS, L. C., from Bettendorf, Iowa, to 3 East State St., Davenport, Iowa.
SWANSON, O. V., from Elm St., Indiana Harbor, Ind., to 6526 Ellis Ave., Chicago, Ill.
THOMSON, W. G. H., from 37th St., Chicago, to P. O. Box 197, Wilkes Barre, Pa.

(*Concluded on Page* 276)

# EMPLOYMENT SERVICE BUREAU

The employment service bureau is for all members of the Society. If you wish a position, your want ad will be printed at a charge of 50c each insertion in two issues of the Transactions.

This service is also for employers, whether you are members of the Society or not. If you will notify this department of the position you have open, your ad will be published at 50c per insertion in two issues of the Transactions. Fee must accompany copy.

Important Notice.

In addressing answers to advertisements on these pages, a stamped envelope containing your letter should be sent to AMERICAN SOCIETY FOR STEEL TREATING, 4600 Prospect Ave., Cleveland, O. It will be forwarded to the proper destination. It is necessary that letters should contain stamps for forwarding.

## POSITION WANTED

REPRESENTATIVE-SALESMAN. Eight years experience in selling steel products such as alloy and tool steels, bars, plates, shapes, axles, wheels and tires, and miscellaneous forgings. At present in charge of sales of forgings, wheels, tires, tool and alloy steels in the Pacific Coast Territory for large steel concern. Would like to correspond with steel company desiring a capable representative on the Pacific Coast. Address 10-1.

METALLURGIST or CHEMIST. Exceptionally good experience together with a record of absolute satisfaction. Available at once. Eastern location preferred. Address 10-5.

CHEMIST and HEAT TREATER. Technical graduate. Experience in chemical, physical testing and heat treating of steels. Eastern location preferred. Reasonable salary. Address 10-10.

WANTED by a practical man with 22 years' experience with some leading firms of the United States, position as Supervisor or foreman of Heat Treating. Address 8-5

METALLURGIST—desires position. Experienced and technically trained in chemical analysis, physical testing, microscopic work and heat treating of carbon and alloy steels. Address 11-5.

YOUNG MAN with four years experience in the heat treatment of steel and who has taken a course in metallography, wishes a position with some concern where there is a chance for advancement. Best of references. Address 9-1.

GRADUATE CHEMIST who has had several years' experience in metallurgical analysis, analysis of iron and steel, etc. His work will be for the present, at least, wholly analytical. Address 10-20.

## POSITIONS OPEN

POSITION OPEN as Assistant Metallurgist with large plant making bearings. College graduate with some years practical experience in heat treating or steel mill work preferred. State in reply education, experience, and salary desired. Address 9-5.

WANTED—In tool and alloy steel research department 1921-1922 technical graduate who has specializvd in iron and steel metallurgy. Duties include running experimental melting furnaces, oil and electric; heating furnaces; and wide range of general work. Position offers good opportunity for future. Address 7-13

UNUSUAL opportunity to secure exclusive sales agency for tool steel mill in Detroit and Los Angeles districts. Mill long established and products of proven quality. Would require experience in selling steel and moderate capital. Address 9-15.

WANTED A MAN—to take charge of heat treating department in an eastern city. An expert metallurgist is not a requirement for this position but a man who is familiar with carburizing and general heat treatment routine. Address 11-15.

WANTED—A single man, graduate of technical course, and with either shop or steel mill experience to represent high grade alloy steel manufacturer with warehouse facilities. The representative would be placed in Milwaukee and would cover the territory in that vicinity under the direction of the Chicago branch. An excellent opportunity for young man who desires to work up as a sales representative. Address 11-10.

WANTED—Metallurgist with mature experience in the melting and casting of nickel-chromium alloys. Permanent position offered by established concern Erecting new plant shortly. Address 11-20.

ANALYTICAL CHEMIST thoroughly familiar with the analysis of steel and steel works materials. Write, stating age, experience and salary required. Address 10-15.

(*Continued from Page 275*)

WICKENDEN, T. H., from Newark, N. J., to International Nickel Co., New York City.
WILLIAMS, C. C., from Bowen Prod. Corp. to 5017 32nd St., Detroit, Mich.
WILLIAMS, H. R., from Electric Alloy Steel Co., Philadelphia, to Atlas Steel Corporation, Dunkirk, N. Y.

## MAIL RETURNED

BUFFINGTON, WM., 250 Ramsey St., Philadelphia, Pa.
EDELIN, J. W., 311 Fourth St., Washington, D. C.
PHILLIPS, J. W., 87 South 14th St., Newark, N. J.
TRAVIS, CHAS., 718 18th St., Rock Island, Ill.
WOLNICK, H. F., 2231 San Jose Ave., Chicago, Ill.

# Commercial Items of Interest

DR. SAMUEL WESLEY STRATTON, director of the Bureau of Standards of the Department of Commerce at Washington for the last 21 years and a noted physicist, was selected on Oct. 11 to be the next president of Massachusetts Institute of Technology. He will assume his new duties Jan. 1, next. Secretary Hoover has accepted his resignation from the bureau.

Dr. Stratton was born in Litchfield, Ill., in 1861, and was graduated from the University of Illinois in 1884. For nine years he was professor of physics, mathematics and electrical engineering in the University of Chicago, after having spent seven years in a similar capacity in the University of Illinois. During the Spanish-American war he was commissioned lieutenant in the U. S. Navy. Yale, Cambridge and the University of Pittsburgh awarded him the degree of Doctor of Science. He is a member of the International Commission on Weights and Measures, American Institute of Electrical Engineers, American Society of Mechanical Engineers, American Physical Society, American Philosophical Society, American Association for the Advancement of Society and the National Academy of Sciences.

The resignation of Dr. Stratton will be felt by the steel industry. He contributed to its welfare not only as director of the bureau, but ofttimes through the channel of constructive technical papers presented before societies connected with the industry. On one such occasion he said: "If industrial problems are to be solved correctly, co-operation between such organizations as the American Iron and Steel Institute, the various steel companies and the Bureau of Standards is essential." And to this end two large laboratories erected during the war have been taken over by the bureau.

Dr. Stratton has repeatedly declined attractive offers from various industries. His retirement is attributed to the meager salary attached to his position. Mr Hoover has endeavored to increase the pay of Government experts, in order to keep them in the Federal service, but Congress would not co-operate and as a consequence these experienced men are returning to industrial fields. In commenting on the retirement of Dr. Stratton, Secretary Hoover said: "The Massachusetts Institute of Technology, an educational institution, finds no difficulty in paying men of Dr. Stratton's caliber three times the salary the Government is able to pay them. Dr. Stratton has repeatedly refused large offers before, but the inability of the scientific men in the Government properly to support themselves and their families under the living conditions in Washington, and to make provision for old age makes it impossible for responsible department heads to secure such men for public service at Government salaries."

Thomas A. Edison has referred to Dr. Stratton as 100 per cent efficient. It is not known who will succeed him as director of the bureau.

The Automatic and Electric Furnaces, Limited, of London, England, have announced that due to the increasing demand for their Wild-Barfield Electric Hardening Furnaces, they are removing both their works and offices to more spacious quarters. They announce that on and after September 29th, their address will be Elecfurn Works, 173-175, Farringdon Road, London, E. C. 1.

In order to facilitate their output, their new works will be equipped with improved machine tools and labor saving devices. Demonstration rooms with furnaces in operation will be provided, and suitable arrangements made for hardening large and small parts for firms who desire to compare both the results and costs with those obtained by gas or solid fuel furnaces. Laboratory and industrial electric muffles will also be available for trial purposes.

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The United States Civil Service Commission announces an open competitive examination for laboratorian (chemical, physical and engineering) on December 6 and 7, 1922 at any of the places listed on the bulletin at which examination is requested in applications received in time to mail examination papers. Vacancies in the Federal classified service throughout the United States, including the Departmental Service, Washington, D. C., at $1200 to $1500 a year, or higher or lower salaries, will be filled from this examination, unless it is found in the interest of the service to fill any vacancy by reinstatement, transfer or promotion.

Applicants should apply at once for form 1312, stating the title of the examination desired, to the Civil Service Commission, Washington, D. C.

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James H. Knapp, industrial furnace engineer, 769 S. Central Ave., Los Angeles, Calif., announces that he is now able to serve those desiring assistance in the solution of their heat treating furnace problems.

Mr. Knapp advises that the manufacturing business is progressing in an excellent manner on the Coast and that he has established a large clientele including the U. S. Electrical and Manufacturing Co. of Los Angeles, the Alexson Machine Co. of the same city, the Regan Forge and Engineering Co. of San Pedro and numerous others.

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Kieth R. Rodney has recently assumed the duties as Manager of the Chrome Steel Works, Chrome, N. J., manufacturers of "Adamantine" Chrome steel.

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Mr. M. F. King, formerly of the Kings Refractories Company has joined the sales and service department of the Quigley Furnace Specialties Company. Mr. King brings to the Quigley organization the benefit of his wide experience in the application of refractories and high temperature cements, and will devote his attention to service and sales work in New York City.

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**Chrome Ball and Bearing Steels**
**Carbon and Alloy Tool Steels**
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**SIMONDS MANUFACTURING CO.**
**STEEL MILLS**
**LOCKPORT, N. Y.**

**Edgar T. Ward Sons Co., Distributors**

The Technical Service, Bulletin No. 7, of the Detroit Twist Drill Company explains in detail the manufacture and heat treatment of forged milling cutters made of high-speed steel. This bulletin contains 5 pages on 8 x 10 loose-leaf stock and is well illustrated with microphotographs and full-sized photographs of forgings and milling tools. These bulletins are available upon request to the Detroit Twist Drill Company, Detroit.

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The Calorizing Company of Pittsburgh have recently issued ther Bulletin No. 2 entitled "Calite Castings for Use in High Temperatures." This bulletin is well illustrated with photographs showing the pouring of a heat of Calite, and various shapes and forms made from Calite. It discusses the physical properties of the material and outlines its various uses in the industry.

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The United States Civil Service Commission announces an open competitive examination for Inspector of Construction; a vacancy under the Navy Department for duty at the Naval Station, Pearl Harbor, Hawaii at $7.20 per diem, and vacancies in positions requiring similar qualifications, at this or lower salaries, will be filled from this examination, unless it is found in the interest of the public service to fill any vacancy by reinstatement, transfer, or promotion. Receipts of applications close November 21, 1922.

Applicants should apply at once for Form 1312, stating the title of the examination desired, to the Civil Service Commission, Washington, D. C.

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The Chicago Flexible Shaft Company have recently issued a new publication entitled "The Melting Pot," which contains articles of considerable interest to heat treaters in general.

The first article appearing in this publication entitled "Heat Treating in Crucible Furnaces" describes the construction of crucible furnaces and contrasts the differences between oven and crucible furnaces in the heat treatment of material. Numerous applications are shown in photographs of the products of the Chicago Flexible Shaft Company.

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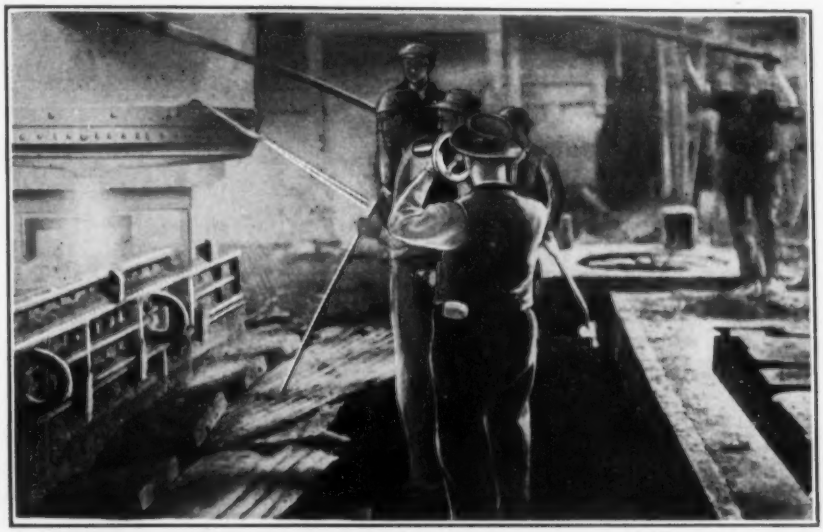
To assist students working their way through Carnegie Institute of Technology, the Jones and Laughlin Steel Company, of Pittsburgh, has arranged to employ students in the steel mills on Friday and Saturday nights or all day Saturday. The shifts are of ten hours length.

Jones and Laughlin is the first large concern in Pittsburgh to come to the aid of students in need of finances. The arrangement is pleasing to the administration at Carnegie Tech because of the opportunity it gives to the students in the College of Engineering to acquire practical as well as theoretical knowledge.

# POURING TEMPERATURES



There is a correct temperature for pouring every metal in every foundry.

With the F. & F. Optical Pyrometer, this can be determined and all heats poured at this temperature, and all castings will be right.

When metal is tapped or poured too hot, it oxidizes and results in a casting of poor structure, to say nothing of the fuel wasted in overheating.

If it is tapped or poured too cold, poor castings also result.

The saving in the loss of castings pays for the Pyrometer many, many times; making the F. & F. Optical Pyrometer a

## MOST PROFITABLE INVESTMENT

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***Write for F. & F. Pyrometer Booklet***

The United States Civil Service Commission states that there is urgent need for eligibles to fill positions of junior engineer and deck officer under the United States Coast and Geodetic Survey, and that an examination for such positions will be held on December 13-14, 1922.

A prerequisite for consideration is that applicants shall have completed at least three and one-half years of a course in civil engineering leading to the degree of B. S. or C. E., in a college, university, or technical school of recognized standing. Graduation with one of these degrees will be required before appointment.

The usual entrance salary is $2,000 a year, in the temporary grade of junior engineer and deck officer. Vacancies in the various commissioned grades are filled by promotion, after six months' satisfactory service. An act of Congress provides that the Commissioned personnel of the Coast and Geodetic survey shall at all times receive the pay and allowances, including longevity pay and all retirement privileges, of the officers of the Navy with whom they hold relative rank.

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Charles T. Bragg, a member of the society, formerly associated with the Michigan Smelting & Refining Co., of Detroit, is now president and general manager of the Michigan Valve & Foundry Co., of Detroit.

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Harrison B. Parker, 12 Elliott street, Reading, Mass., is now foreman of the heat treating department of the Trimont Mfg. Co. of Boston.

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Felix Kemp, formerly of Dunkirk, has accepted a position with the Whitman-Barnes Co. of Akron.

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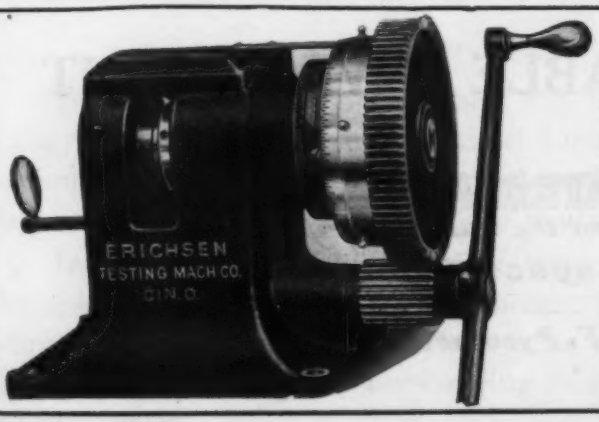
Marcus A. Grossman, formerly of Chaleriox, Pa., where he was mill metallurgist for the Electric Alloy Steel Co., has moved to Dunkirk, N. Y., since the consolidation of the Atlas Crucible Steel Co. and the Electric Alloy Steel Co. under the name of the Atlas Steel Corporation, where he has assumed an important metallurgical position.

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